CI/SfB Xt6

Designed Micro Cement & Lime Grout Anchoring Solutions

CINTEC

CINTEC

BROCHURE UPDATE RECORD

DATE	UPDATE No.	CINTEC PERSONNEL	
		NAME	SIGNATURE

CINTEC

GLOSSARY Of TERMS USED IN THIS BROCHURE

CHS - Circular Hollow Section
DRB - Deformed Ribbed Band
JAR - Joint Remedial Anchor
RAC - Remedial Anchor Cavity
RAD - Remedial Anchor Large Diameter
RWT - Rigid Wall Tie
SHS - Square Hollow Section
ST - Stud
WSA - Wall Supporting Anchor

INTRODUCTION

Research in the 1960s revealed that the construction industry needed an improved fixing system. Thus, the Cintec Designed Anchor System was developed which meets the following objectives:

1. EASILY FIXED EVEN IN WEAK SUBSTRATES.
2. EASILY USED IN POOR QUALITY MATERIALS AND IN BRIDGING CAVITIES.
3. SYMPATHETIC WITH EXISTING STRUCTURES - CEMENTITIOUS BASED.
4. VERSATILE.
5. EASILY DESIGNED FOR DIFFERENT APPLICATIONS BY DESIGNERS.
6. PERMANENT.
7. CAPABLE OF RAPID MANUFACTURE.

The technical embodiment is simple in that the main steel body of the anchor is completely surrounded by a fabric sock. The anchor is then located in an oversized drill hole joining the materials to be anchored together. Fluid grout is then injected under pressure through the middle of the anchor, until it reaches the remote end. There, it passes through a series of grout flood holes into the fabric sock. The entire assembly inflates like a balloon under the pressure. The excess milk of the grout and bonding agent passes through the fabric sock, both fixing and providing a mechanical and chemical bond to the parent material. Variation in the size and shape of the individual components enable the basic method to be extended to meet the designer's requirements.

The fixing illustrations shown in this brochure are standard applications.

The basic principle of the fixing permits the designer to create easily individual fixings to meet the particular requirements.

Cintec International Ltd., Factory Road, Newport, South Wales NP20 5FA
Telephone: +44 (0) 1633 246614 Fax: +44 (0) 1633 246110

Design Concepts

The Cintec Anchor System is a versatile method of structural reinforcement tailored to meet the specific strengthening and repair requirements of individual projects. From historical buildings and monuments to bridges, high-rise blocks and harbour walls, Cintec has the worldwide reputation for resolving the technical challenges of structural preservation, whilst remaining sensitive to the original architecture.

The Grout

Presstec grout is a one component mix, which has the same characteristics as Portland Cement, with graded aggregates and other constituents which, when mixed with water, produce a pumpable grout that exhibits good strength with no shrinkage.

Presstec is made in accordance with the following German DIN standards:

DIN EN 197-1	DIN EN 196	DIN 4226
DIN EN 1367	DIN EN 932	DIN EN 933
DIN 1097	DIN EN 18555	DIN 18557

The grout is independently checked both during manufacture and before final despatch. This control is undertaken by the Material Testing Institute of the German Federal State of Northern Rhine-Westfalia MPA NRW. Proof of the inspection is marked on every bag with the control mark '**U**' or 'Uberwacht Controlled'.

DIN 18156 UBERWACHT

Typical values of the grout are:-

MEAN TENSION		PRESSTEC 2000	
N/mm^2 - MPa	PSI	MPa	PSI
@ 3 days = 2.5	362	@ 24 hrs = 3	435
@ 7 days = 3.5	507	@ 7 days = 5	725
@ 28 days = 4.5	652	@ 28 days = 9	1305

MEAN COMPRESSION		PRESSTEC 2000	
N/mm^2 - MPa	PSI	MPa	PSI
@ 3 days = 21.2	3074	@ 24 hrs = 40	5800
@ 7 days = 37.2	5395	@ 7 days = 54	7830
@ 28 days = 51.5	7469	@ 28 days = 65	9425

The grout has inorganic flow and anti-shrink additives which meet the requirements of German DIN standards. The grout has also been tested using accelerated shrinkage tests and found to be satisfactory. The grout bonds to the parent material through the sock as
it is inflated.

The resistance strength of the insitu construction to resist the anchor load depends on the section utilised. If the section is solid bar, the anchor body is deformed. If the anchor is circular, the section is crimped. On square section material, a plate almost the size of the bore hole is welded to the anchor at both ends to ensure the strength is mobilised.

The Sock

The fabric sleeve is a specially woven polyester based tubular sock with expansion properties to suit the diameter of the bore hole and substrate. The mesh of the sock is designed to contain the aggregates of the mixed grout while still allowing the cement enriched water (milk) to pass through the sock both sizing and bonding the substrate. The sock is manufactured in sizes from 20mm to 300mm in diameter and is adjusted to suit each individual application.

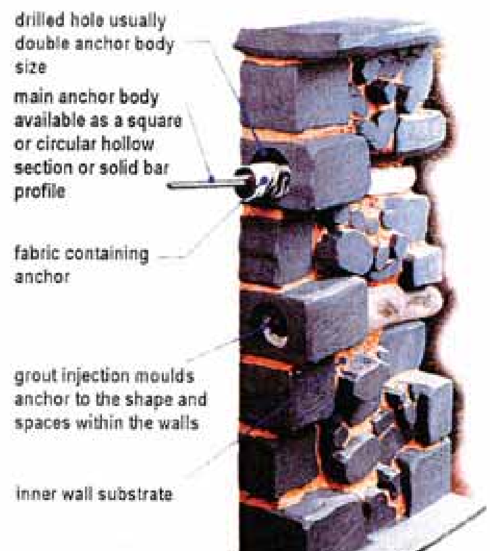
The Reinforcing Member

The types of reinforcing members utilised depend largely on the loads anticipated and the life expectancy of the anchor.

A few examples are listed below:

The Parent Material

The strength of the parent material and/or mortar can govern the anchor capacity. Design checks on the parent material capacity can be based on the resistance strength of the insitu construction to the anchor force according to the national standards. When the parent material or mortar strength is indeterminate, the capacity of the material/mortar can be determined from insitu anchor tests.



Model courtesy of WT Fixings & Combi-tec

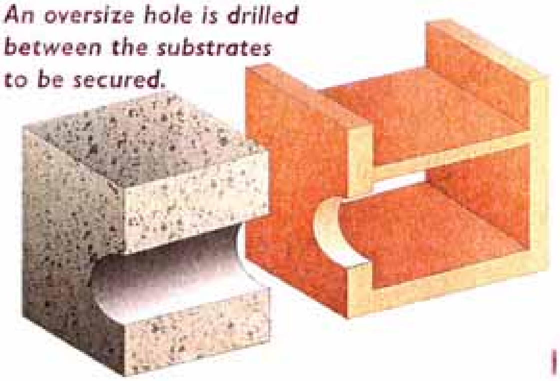
Steel Sizes	Steel Types	Standard	Grade 304	Grade 316	Class	0.2% Proof Stress (KSI) N/mm^2 / MPa		Ultimate Tensile (KSI) Strength N/mm^2 MPa	
8mm x 0.75mm (5/16 x 0.04)	Circular Hollow Section	BS 6323	304 S11			185*	26.8	480*	69.6
10mm x 1mm (3/8 x 0.04)	Circular Hollow Section	BS 6323	304 S11			185*	26.8	480*	69.6
15 x 15 1.5mm (5/8 x 5/8 x 0.06)	Square Hollow Section	ASTM A554	AISI 304	AISI 316		210*	30.4	510*	73.9
20 x 20 x 2mm (3/4 x 3/4 x 0.08)	Square Hollow Section	ASTM A554	AISI 304	AISI 316		210*	30.4	510*	73.9
30 x 30 3mm (13/16 x13/16 x 0.12)	Square Hollow Section	ASTM A554	AISI 304	AISI 316		210*	30.4	510*	73.9
M8 to M50	Allthread Studding	BS 6105	AISI 304	AISI 316		210	30.4	500	72.5
5/16 2"						450	62.2	700	101.5
						600	87.0	800	116.0

The grade 316 contains Molybdenum, which improves the resistance to corrosion and is beneficial especially in chemically aggressive environments. Higher grades of stainless steel are available for specialist applications.

* For guidance only. Figures are based on steel before forming and welding.

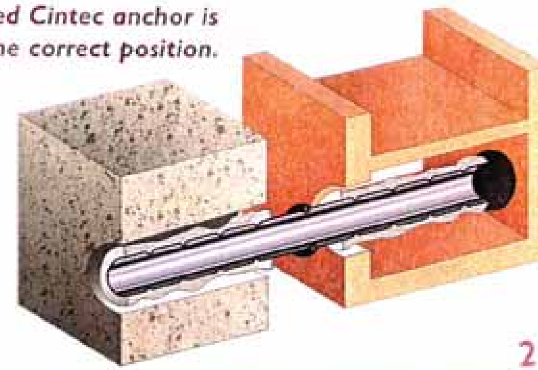
Anchor Principles

An oversize hole is drilled between the substrates to be secured.



1

The designed Cintec anchor is placed in the correct position.

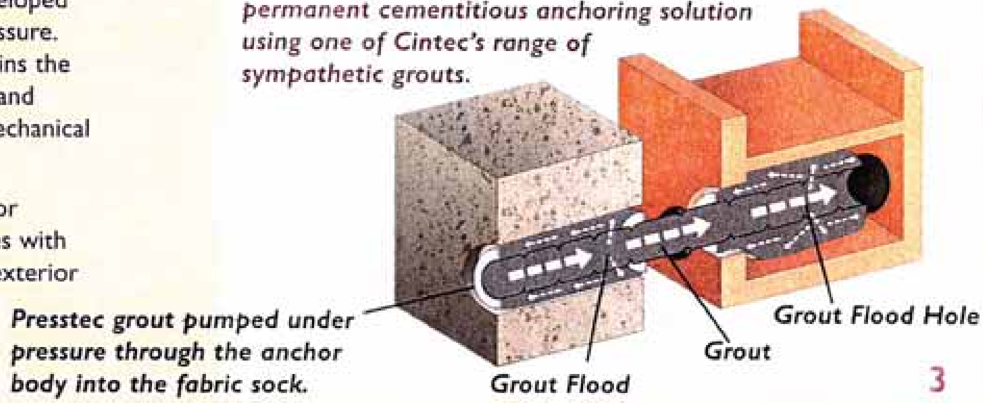


2

The Cintec system comprises a steel section in a mesh fabric sleeve, into which a specially developed cementitious grout is injected under low pressure. The flexible sleeve of woven polyester restrains the flow and moulds the anchor into the shapes and spaces within the walls, providing a strong mechanical bond.

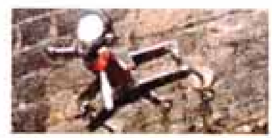
The large surface area of the expanded anchor creates a reinforcement system that dispenses with the need for unsightly patress plates on the exterior of the structure, providing an invisible mend.

The anchor is inflated like a balloon to provide a permanent cementitious anchoring solution using one of Cintec's range of sympathetic grouts.



3

Testing Regimes



Seismic testing on full scale model of Sao Vicente de Fora Monastery – Italy

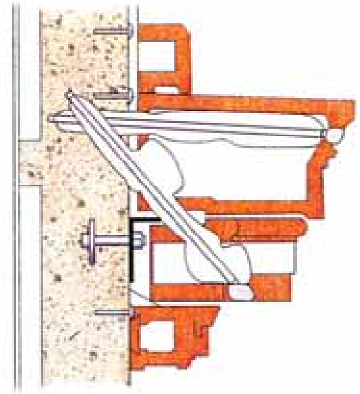
Anchor pull out tests following exposure to extreme heat in the burnt out remains of Fullers' Brewery

On location tensile load testing in Sandstone

Measurements being taken during load testing of masonry arch bridge at T.R.L.

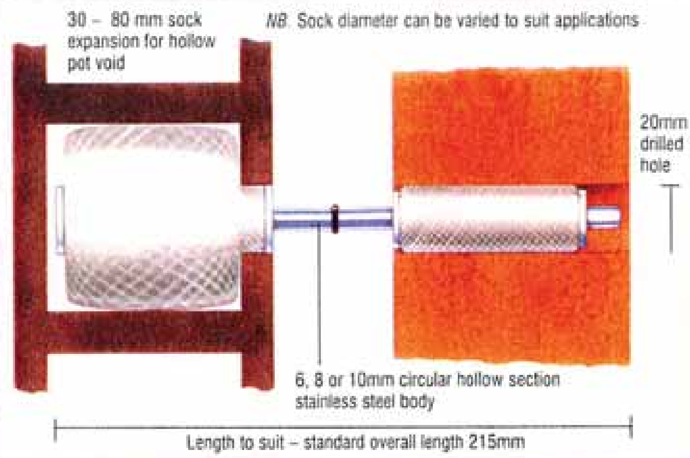
Anchor Principles

TERRA-COTTA – Typical Detail

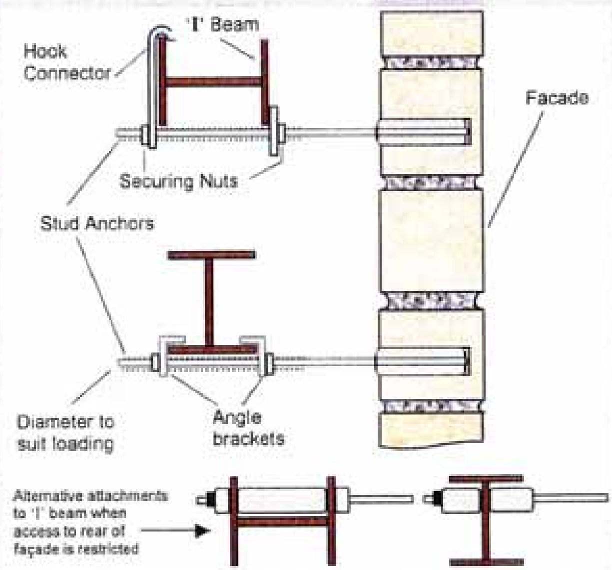


Typical, 12mm dia. solid round threaded Cintec Anchor in 32mm dia hole 64mm dia sock min. 2 Per T/C unit size & length subject to site conditions.

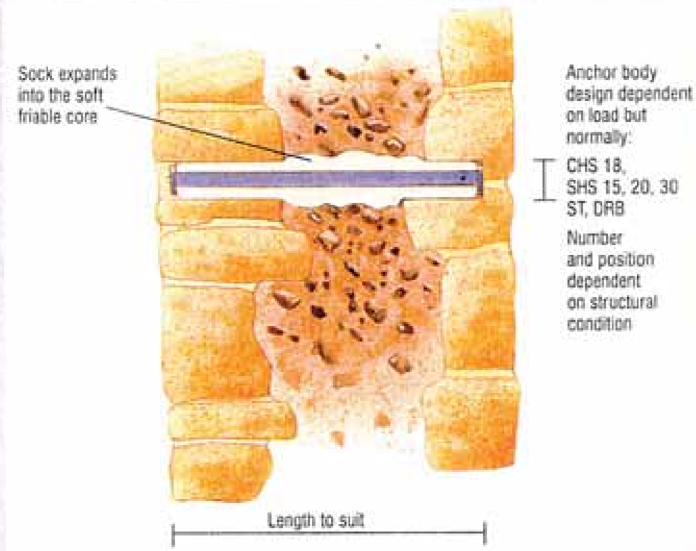
RAC for Hollow Pot/Brick Cavity Wall



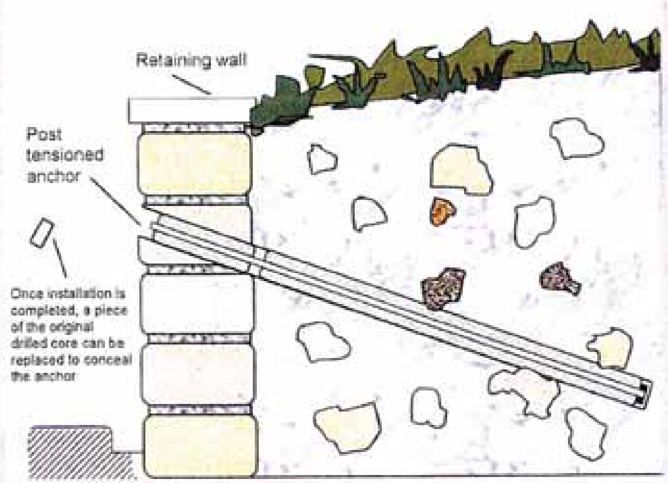
'I' Beam Securements to Masonry Facades



Stitching Anchor – Type CHS

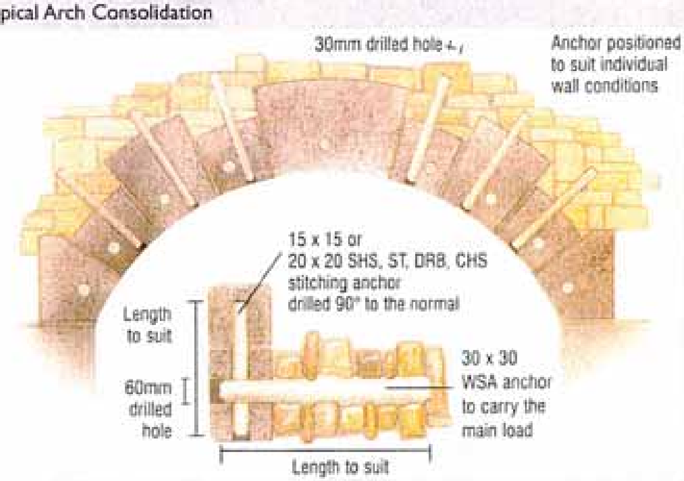


Retaining Wall/Ground Anchoring



Stitching Anchor Application – Type CHS

Typical Arch Consolidation



CHS – Circular Hollow Section
ST – Stud
RAC – Remedial Anchor Cavity
DRB – Deformed Rib Bar
SHS – Square Hollow Section
WSA – Wall Supporting Anchor

TRAINING CERTIFICATION

THE TRAINING COURSE

The object of the training course is to give the installer a complete knowledge of the Cintec Anchoring System. During the course the Cintec Anchoring System is demonstrated, and the installers given hands on experience as to the techniques of installation.
Upon completion of the course, successful trainee's are certificated and issued with an identity card. The company is then entered onto the Cintec approved installers list.

THE CERTIFICATION / INSTALLERS MANUAL

The certification procedure and its accompanying training manual provide a basic guide to the installation of the Cintec anchor system. Whilst it provides a firm basis for its use, it cannot comprehensively cover all possible applications. Additional information and training is available from Cintec International Ltd. subject to prior arrangment.

The requirements of the Health and Safety Act are drawn to the attention of trainee installers, particularly with regards to the use of the grout and equipment.

The use of diamond core and rotary percussive drills is presented. More detailed instructions are given in the manual about diamond core drills in hand held applications.

Grout and grout mixing are presented. This stage is the most important in the application of the Cintec Anchor System. The grout has been carefully designed and if mixed in clean equipment and according to specified procedure, successful grouting can be routine.Site and equipment cleanliness are fundamental to safety and successful installation.

Successful grout injection relies on good treatment of both anchors and grout from the moment of their arrival on site. Emphasis is placed on their careful storage and handling.

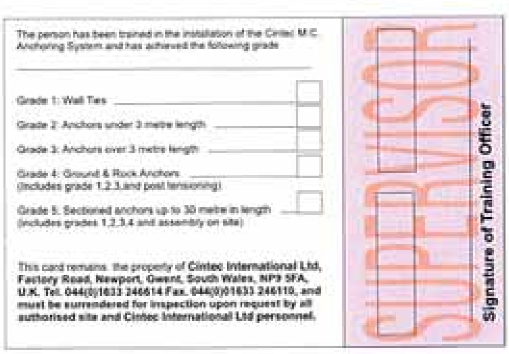
The operation of the grout pressure pot is detailed in the manual along with graphical illustrations. Emphasis is placed on the requirement for cleanliness for all aspectes of the mixing and grouting. Graphical illustrations are given of the steps in the grouting procedure, together with details of the customary range of injection pressures.

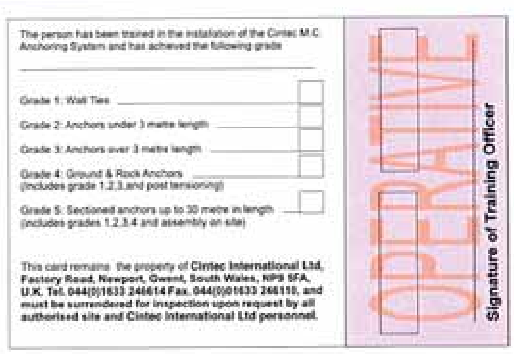
The two stage mixing of the grout is detailed carefully. The specified procedure leads to a grout which is easily and successfully injected. Details are given to enable the installer to monitor the mixing procedure and subsequent injection to ensure the grout injection is successful. Details for hot and cold weather grouting are given.

Anchor injection is specifically illustrated, since this provides visual and tactile evidence of successful anchor installation. Attention is drawn to the visible excess milk grout which should be present at the front of the sock and the front of the anchor should be firm to the touch and not move in any direction. The excess grout milk is washed off immediately.

IDENTITY CARDS

An installer is required to carry his identification card on site whilst undertaking all work requiring the use of the Cintec Anchoring System. The card must be available upon request to all authorised site and Cintec International Ltd. personnel. Cintec carries the responsibility for the product whilst the installer has the responsibility to carry out the work in a professional manner.





ACCELERATED MOISTURE/TEMPERATURE CYCLING: TESTS BY BUILDING RESEARCH ESTABLISHMENT

Cintec wall ties were subjected to accelerated moisture/temperature cycling to model the insitu conditions of the ties in traditional cavity construction. The tested wall tie was a standard 8mm diameter x 1mm CHS stainless steel section in a nominal 16mm diameter drill hole. The tie had a conventional polyester sock and the standard PRESSTEC grout was pressure injected in the usual manner. Clay facing bricks of 212mm x 100mm x 65mm size were used as the test parent material.

The test programme assumed that the insitu cavity construction would be fully saturated bay rain-water at least once a year. It was established by trials that a half hour soak in a water tank, followed by a minimum of 2 days drying in an electric oven heated to 40°C(±2°C) to constant weight, would satisfactorily model insitu conditions.

Five pull out tests on the brick anchor specimens were undertaken seven days after construction, then at 10, 20, and 40 cycles of wetting/drying of the specimens. The tests were undertaken in a Universal Testing machine, calibrated to BS1610: 1985 Grade 2. A side load of 3.5N/mm^2 pressure was applied to the bed faces to simulate conditions of confinement of the brick insitu.

The full saturation value after 24 hour immersion of the brick in water was 17.5% compared to a water absorption of 15% achieved after the test soak period of 30 minutes. The nominal brick compressive strength was 43.3N/mm^2. The test pull out values were as follows:

Specimen No.	After 7 days cure	After 40 wetting/drying cycles
1	10.45	9.10
2	12.23	11.00
3	10.68	10.00
4	10.45	12.90
5	10.90	9.79
Mean	10.94	10.56
Coefficient of Variation%	7.00	14.00

A one way analysis of variance showed the affect on the pull out performance was not significant. Regression analysis (linear as well as polynomial) confirmed this lack of significance.

The general conclusions were:

1. The pull-out performance of the test/anchor clay brick combination would not be adversely affected in any significant manner in conditions of exposure to rain simulated in the test.

2. Failure of the specimens was typically by pull-out of the steel tube, for steel strength primarily governed the capacity of the anchor.

3. Pull-out performance of the anchor/brick system appeared to be directly proportional to the length of embedment.

The full report is available on request.

GROUTING EQUIPMENT AND PRINCIPLES

A pressure pot capable of being pressurized to 3-5 bar

The outlet on the pressure pot needs to be altered to accept a 1/2" bsp hose adapter with 4 Mts. of reinforced 1/2"tubing and a 1/2" quarter turn ball valve. A 1/2" hose adapter or threaded attachment needs to be screwed into the valve to enable plastic mastic nozzles to be pushed or threaded onto the front of the valve. This assembly will then serve as the grout delivery hose and control valve.

- 7 to 10 c.f.m compressor (minimum).
- Mixing paddle or whisk wit a 6" cage.
- Electrical drill for mixing (560 r.p.m.).
- Two large mixing buckets (18 lt. min.).
- Measuring jug in litre increments.
- A large flour sieve (small mesh).
- Power generator or 110v transformer.
- An adequate supply of mastic nozzles to suit control valve on delivery hose.
- Safety goggles and gloves.

All equipment must be kept in a clean condition. Do not use oil or releasing sprays inside the pressure pot as this may contaminate the grout.

Safety goggles and gloves must be worn at all times when mixing and injecting grout.

GROUT MIXING

The grout is packed in 25 kg bags and is mixed with clean cold water.
The normal mixing ratio is 6 ltrs of water to one 25 kg bag of grout. One 25 kg bag will yield 16 ltrs of fluid grout when mixed.
The 6 ltrs of water can be increased by 10% (600ml) in hot weather (20°C+) and when the subtsrate is very dry or porous or the injection process is through very small injection tubes.
Do not increase the water content outside these parameters as this will considerably weaken the strength of the set grout.

The grout must be mixed as follows:-

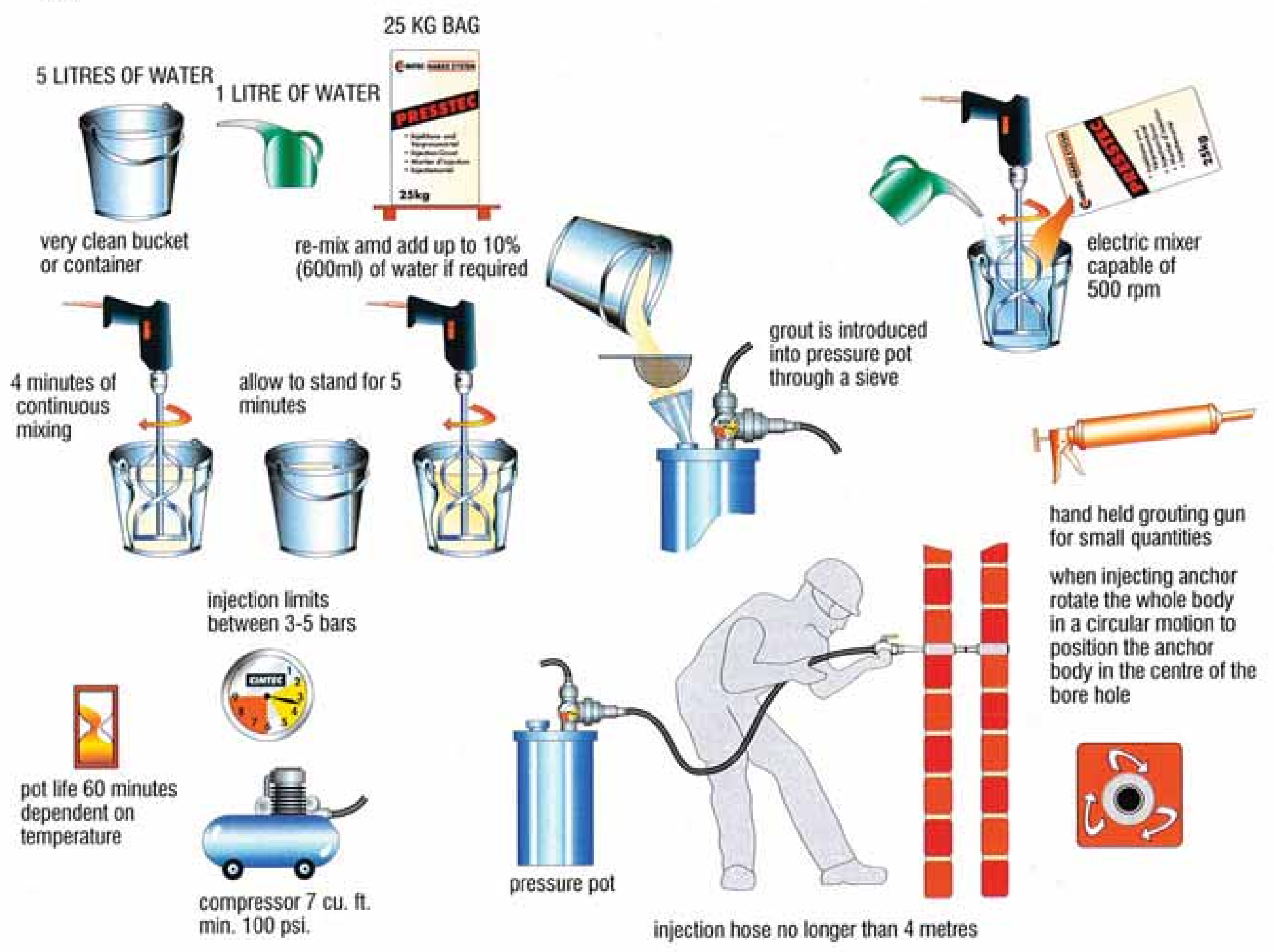
Place 5 ltrs of clean/cold water into a clean mixing bucket and slowly add approx. 3/4 of one bag of Presstec grout while mixing.
Add a further 1 ltr of water (to make up the required 6 ltrs) and the remaining grout.

Continually-mix the grout for 4 minutes removing all the dry mixture from the sides of the bucket.
Allow to stand for 5 minutes, during which the mixture will start to thicken, the amount the mixture thickens will depend on the ambient temperature and the temperature of the dry grout and water.
At this stage some or all of the 10% extra water may be added to achieve a smooth creamy texture with no peaks forming on the surface.
Pour the mixed grout into the pressure pot through the sieve.
Pressurise the pot from 3 bar to 5 bar dependent on the type and length of anchor being installed.
Cut the plastic mastic nozzle to fit the anchors orifice. On anchors with injection tubes, prime the tube with water and cut the mastic nozzle to fit over the injection tube.
Test the grout flow into a suitable bucket. If the grout flow is continuous and of sufficient pressure the anchor can be injected.
Carefully push the nozzle into the anchors orifice or over the injection tube and position the anchor to the specified depth (minimum 25mm beyond face of brickwork).

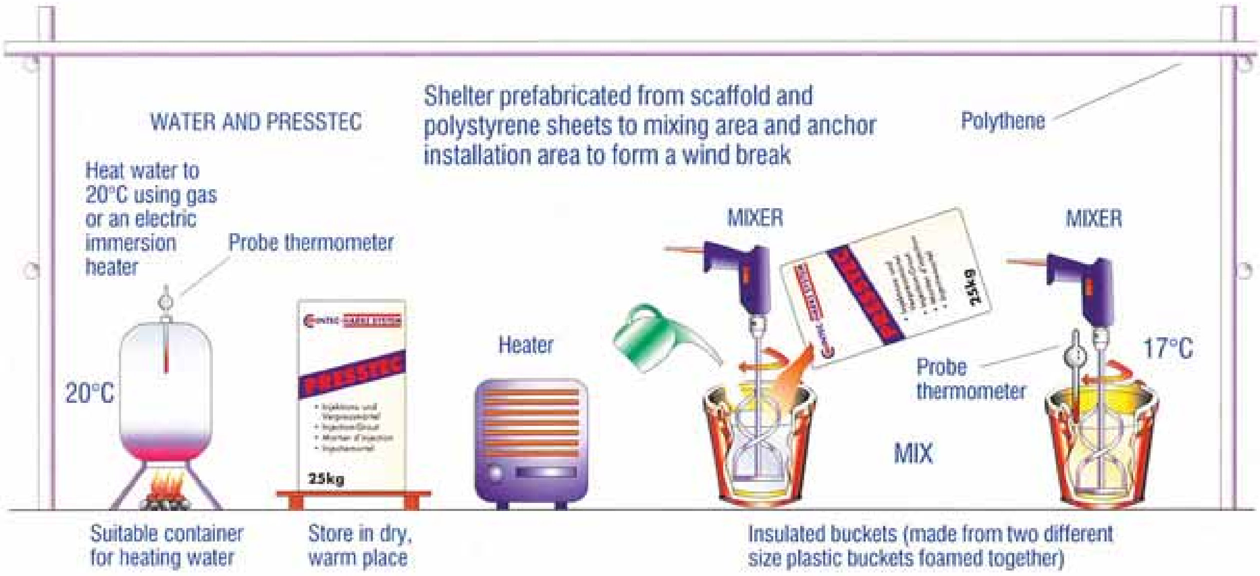
Turn on the control valve and the grout will flow to the rear of the anchor and inflate the sock along the length of the anchor to the front.
Move the anchor in a circular motion to facilitate the front grout flow and to ensure the anchor is centred in the borehole upon completion.
At this stage the anchor wil be felt to be locking in the bore hole and a grout milk will appear at the front of the anchor (note the colour change in the sock).
Maintain the pressure until the grout milk has stopped flowing and the sock at the front of the anchor cannot be compressed.
Use a sponge or cloth during this process to soak up the excess grout milk and avoid the milk running down the face of the brickwork/stonework.

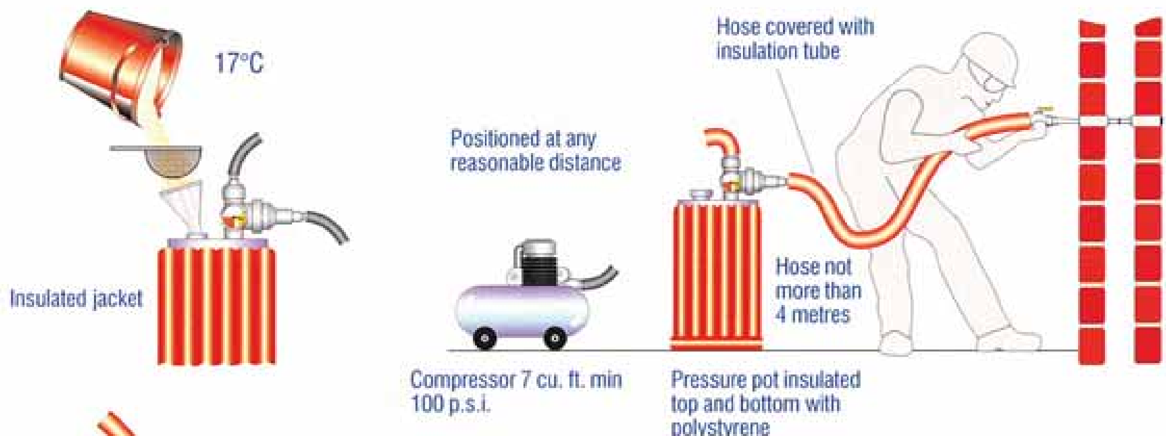
Any grout or milk on the wall must be washed off immediately.

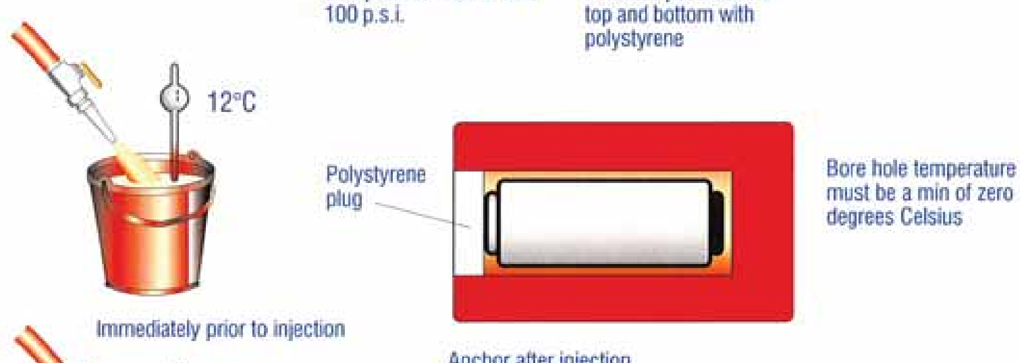
Please note that the anchor is not fully inflated until the grout milk has stopped flowing through the sock.
Pressure must be maintained to allow this to be achieved.
With large injection orifices a suitable plug must be placed in the injection port immediately after removing the nozzle.



COLD WEATHER HINTS







INJECTION PERIOD

AM
Not before 9.15am

PM
Not after 2.45pm

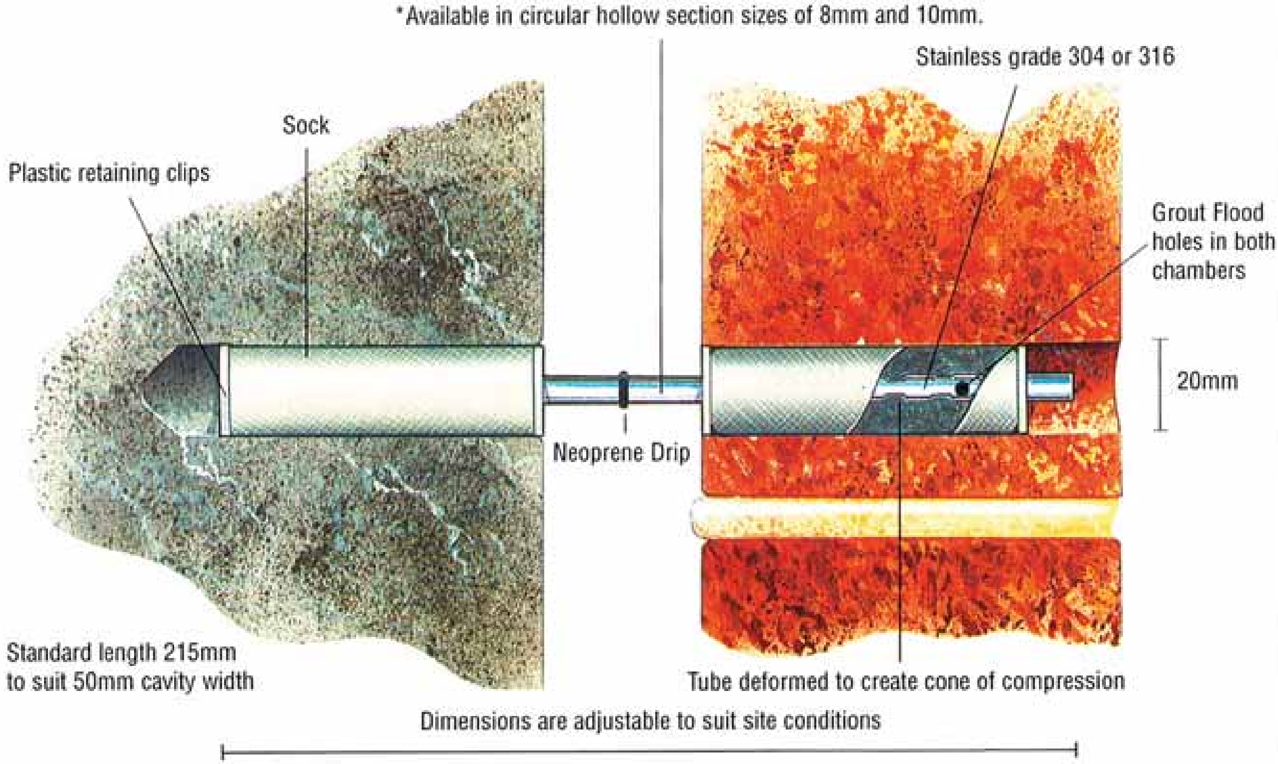
RECORD

Date
Batch number
Water temperature
Temperature of bore-hole prior to inflation of anchor
Final mixing temperature
Temperature prior to injection
Final pot batch temperature

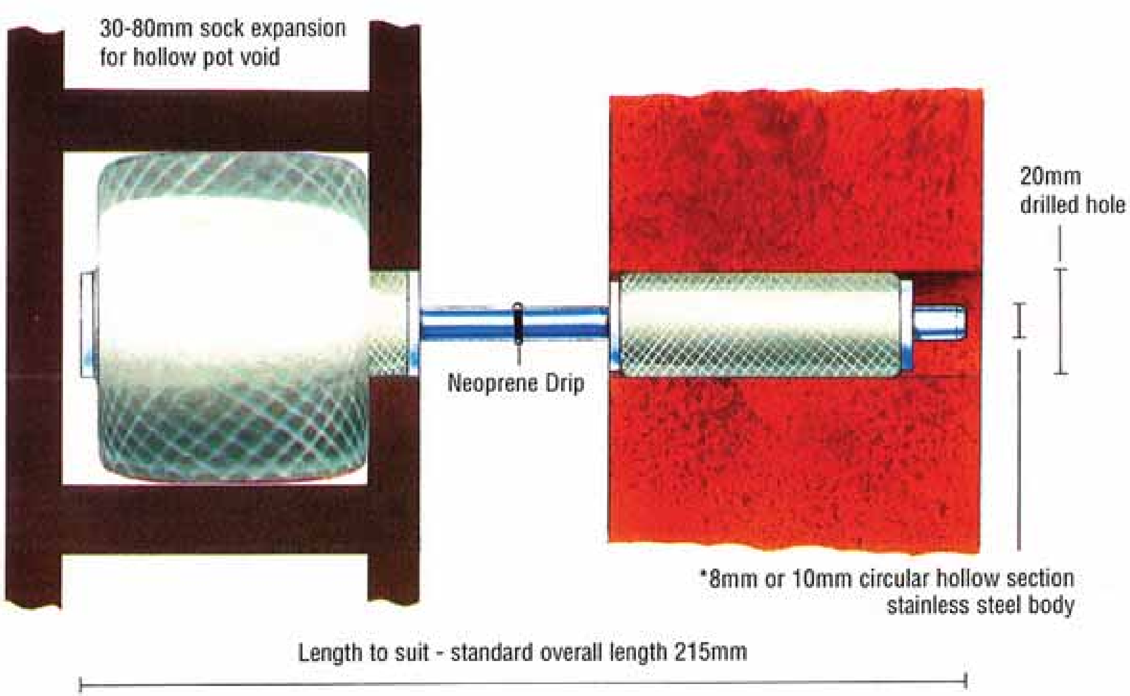
CINTEC

Anchor Technical Information

Single fixing RAC for single brick application



RAC for hollow pot/brick cavity wall

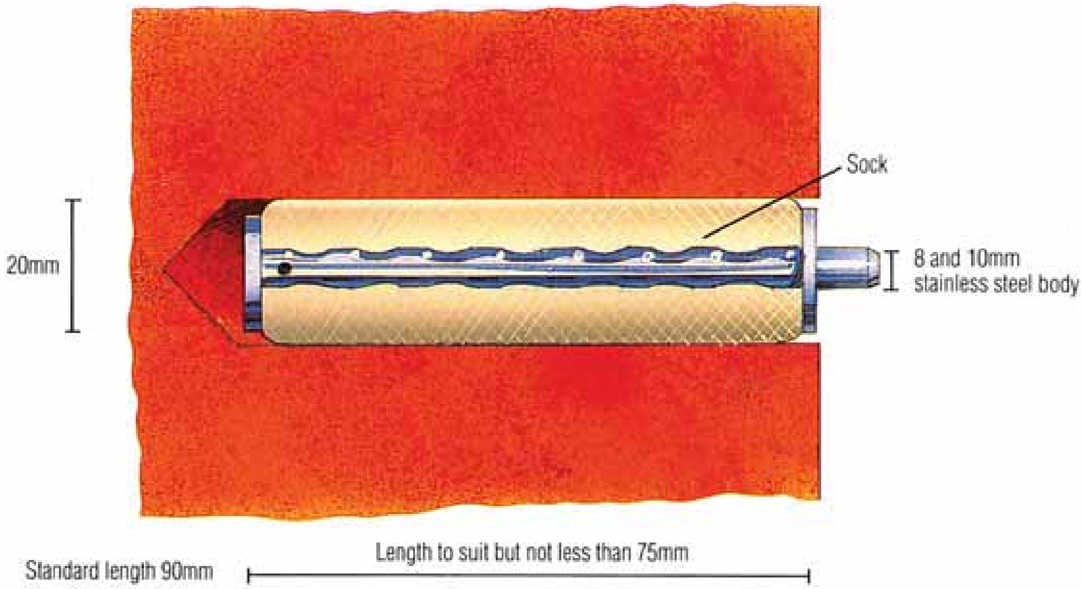


NB. Sock diameter can be varied to suit applications

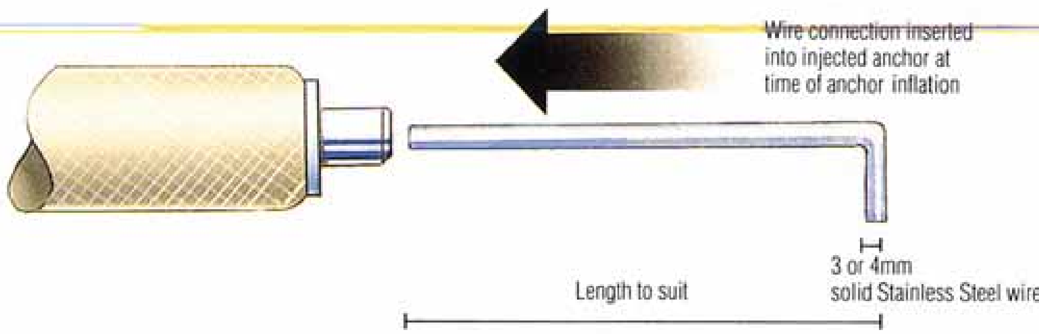
WALL TIE SINGLE SKIN

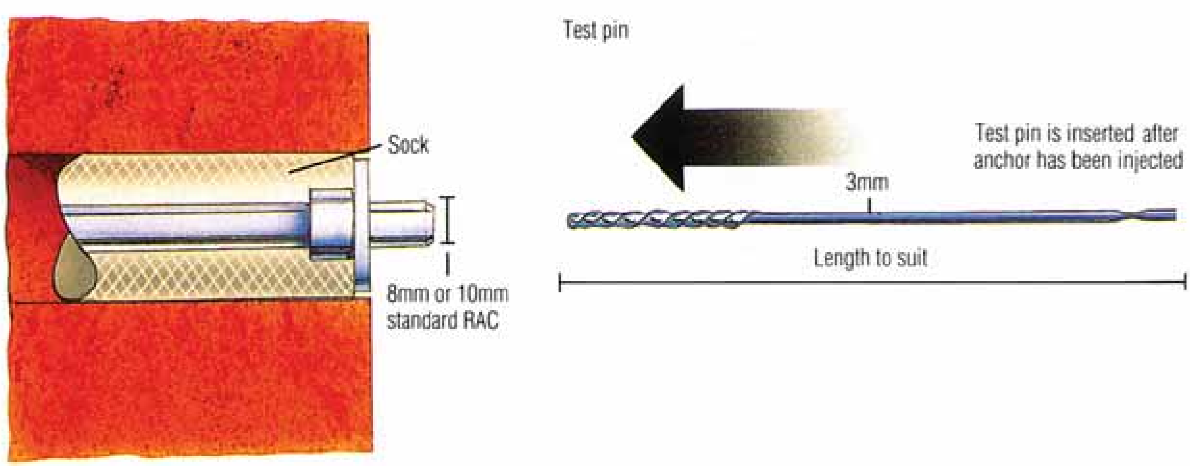
TYPE CHS 8 x 80mm

Single fixing CHS 8 for single brick application

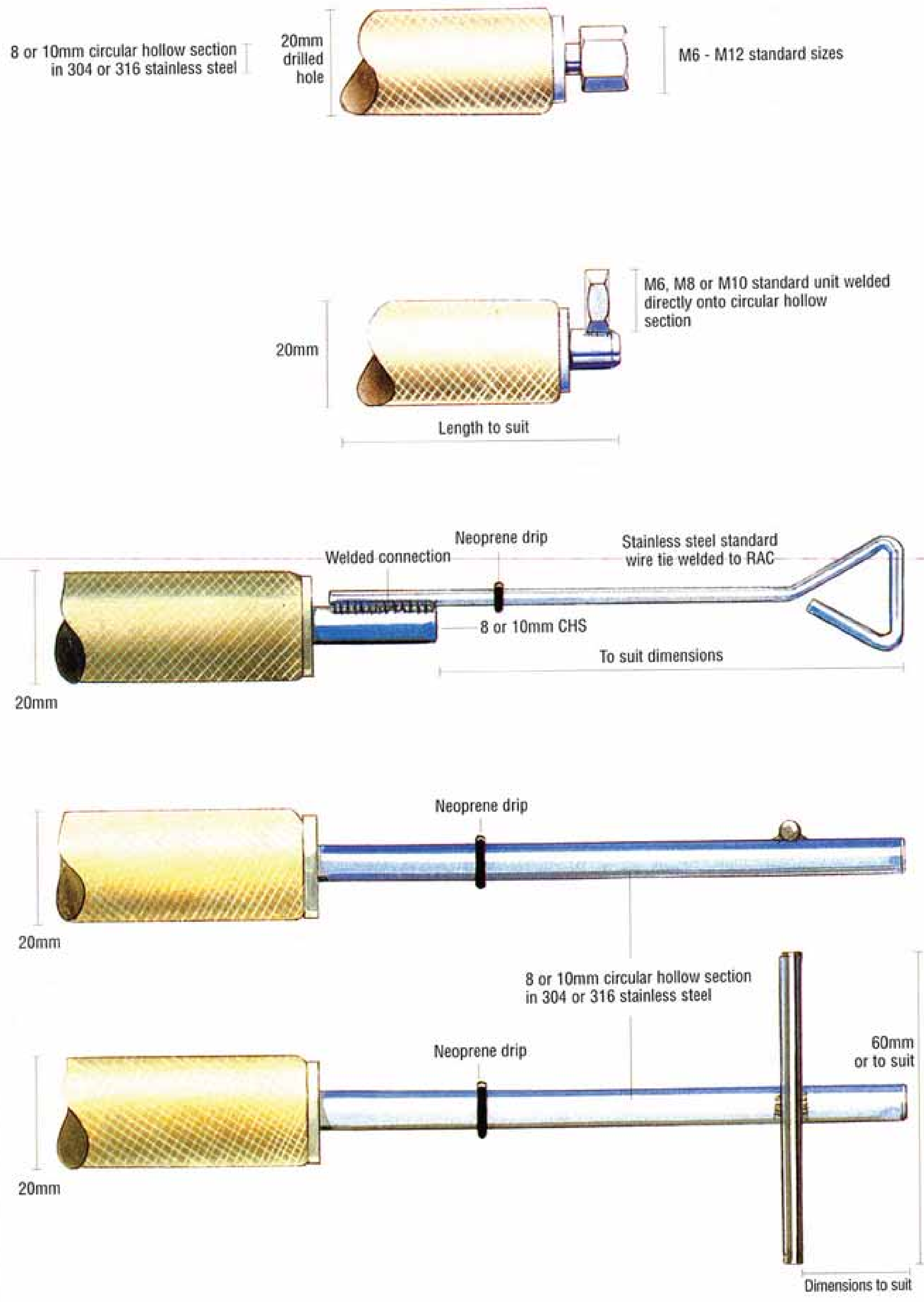


Standard outer leaf attachment for single CHS 8



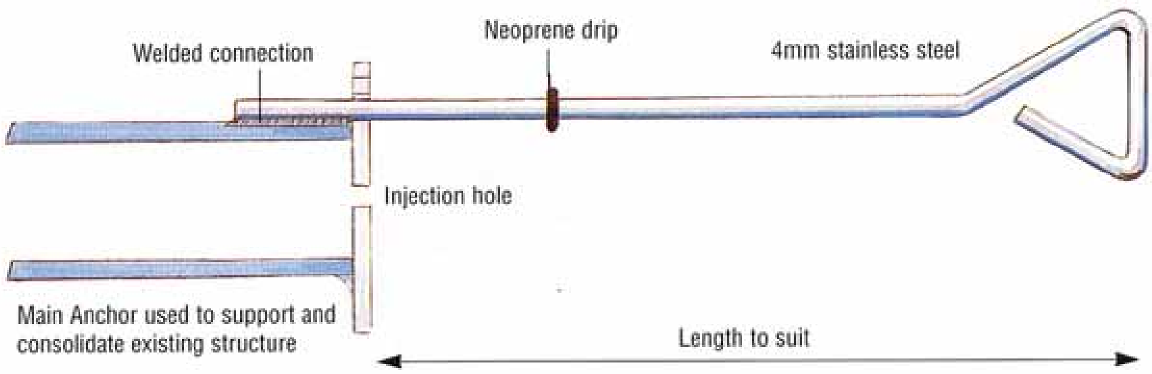


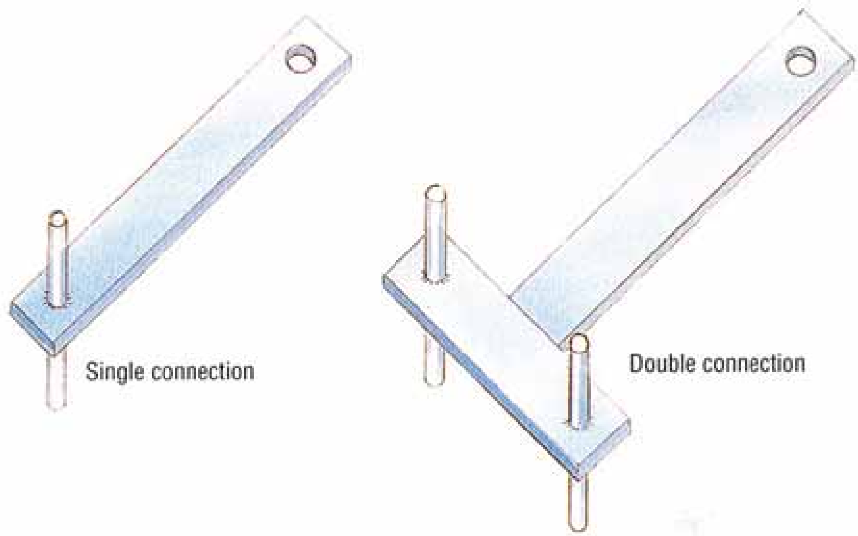
STANDARD WELDED ATTACHMENTS

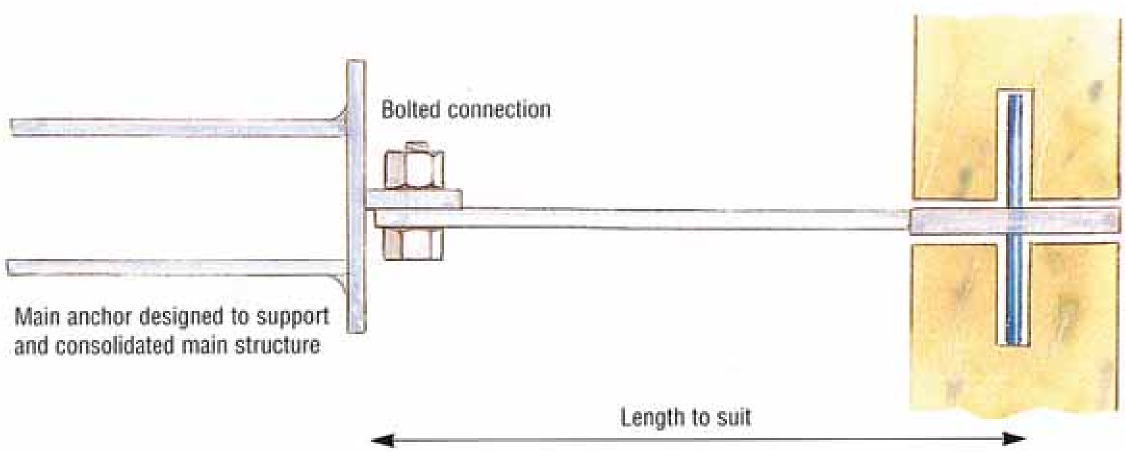


SELECTED ATTACHMENTS

Wall tie extension to support new work

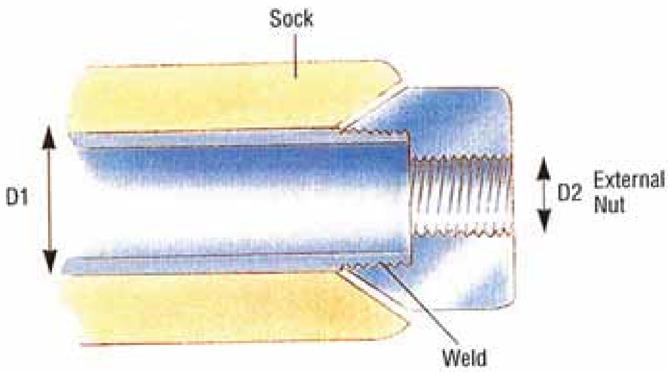


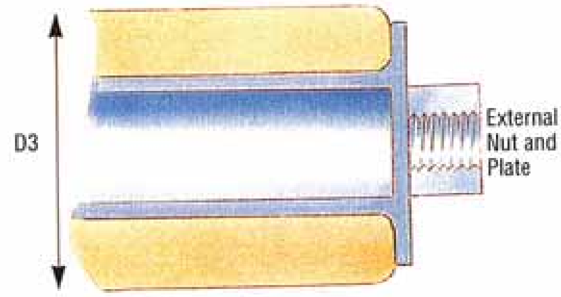




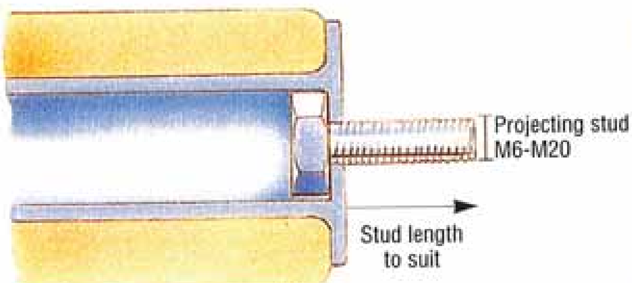
STANDARD WELDED ATTACHMENTS

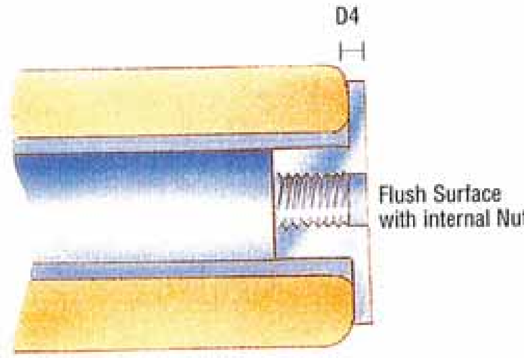
TYPE RWT & WSA





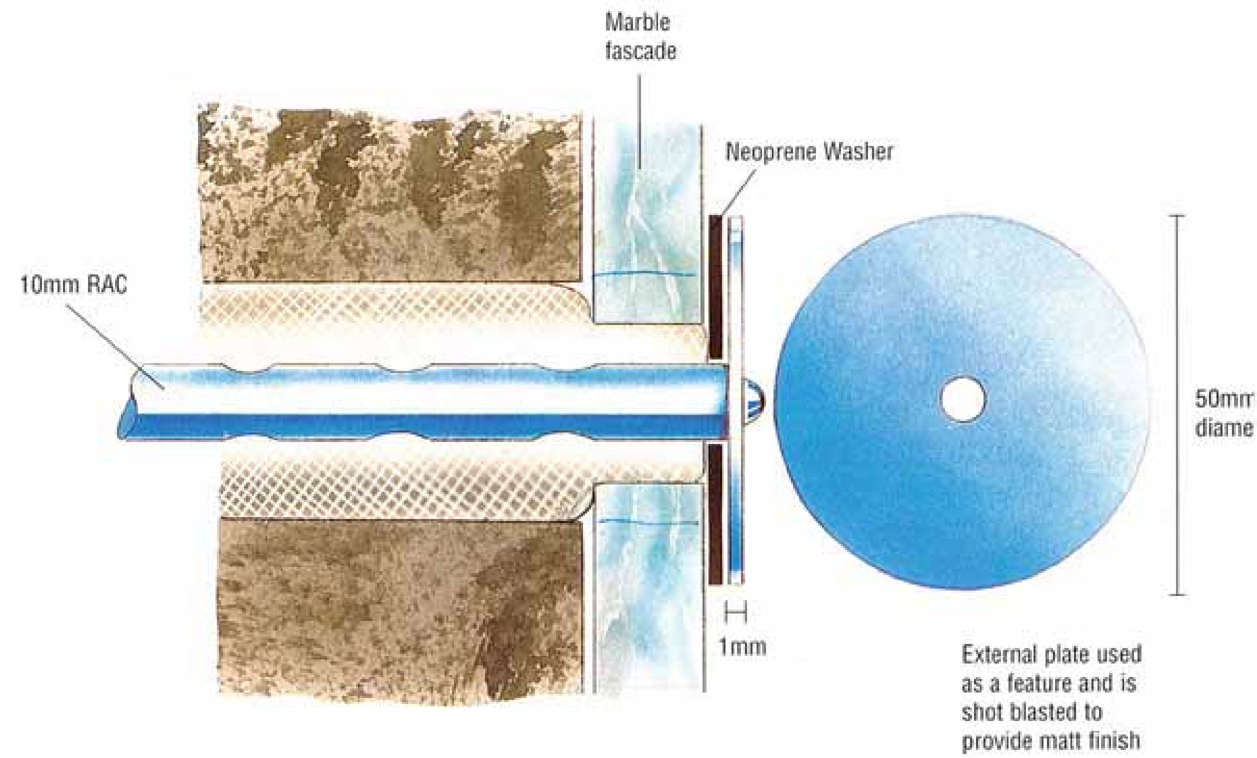
Section through





RWT and WSA Standard Welded Attachments

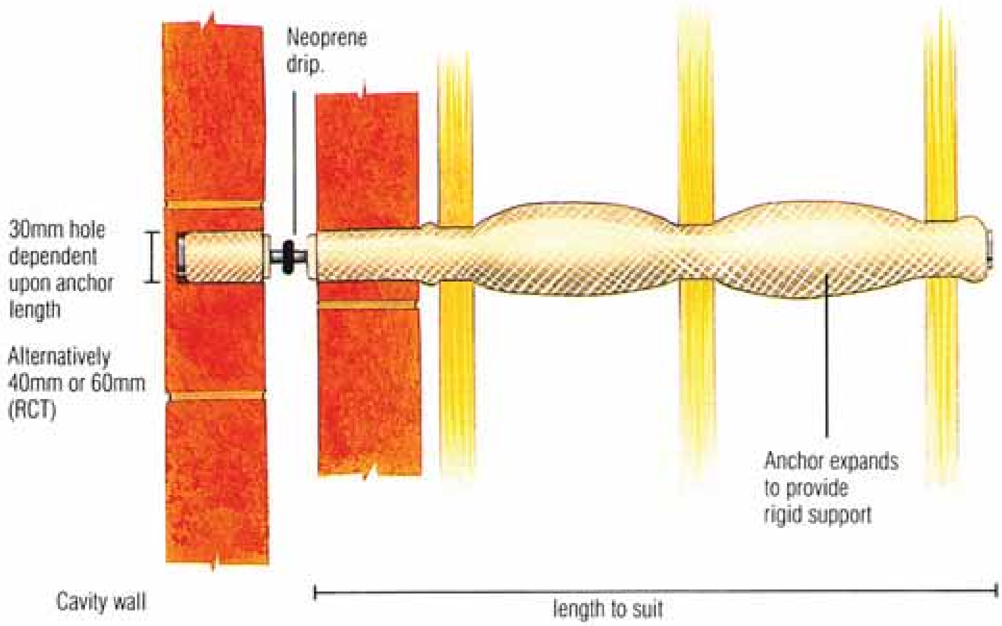
SECTION SIZE			
D1	**D2**	**D3**	**D4**
15 x 15	M6 to M16	30mm to 80mm	1.5mm to 4.0mm
20 x 20	M6 to M20	40mm to 140mm	1.5mm to 4.0mm
30 x 30	M6 to M30	60mm to 200mm	2.0mm to 6.0mm


Marble fascade
Neoprene Washer
10mm RAC
50mm
diame
1mm
External plate used as a feature and is shot blasted to provide matt finish

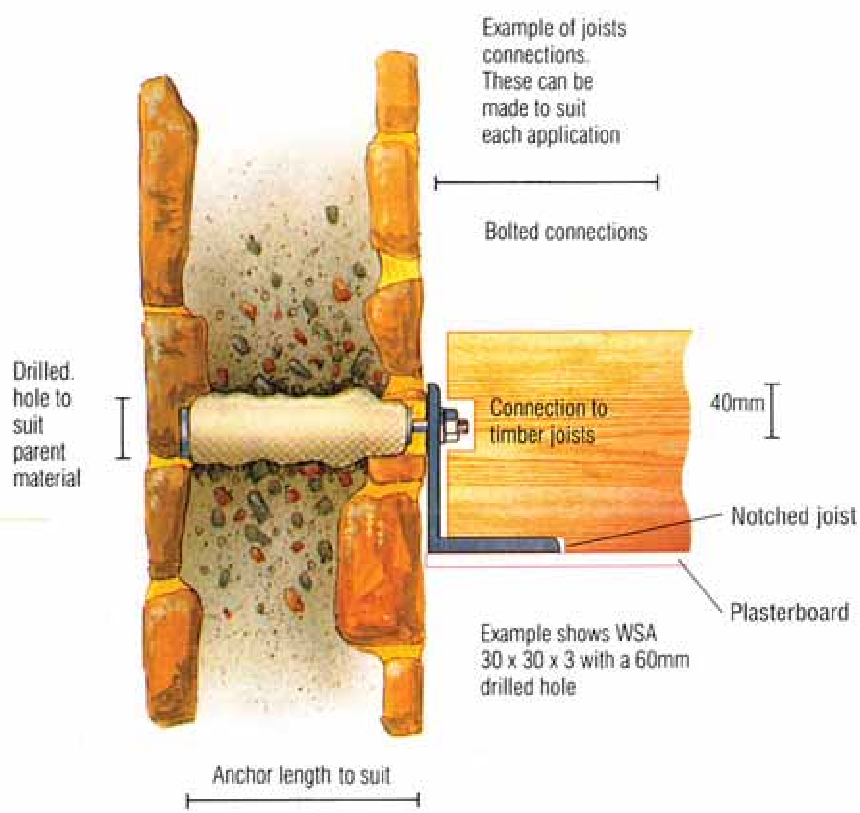
WALL TIE LATERAL RESTRAINT APPLICATION TYPE CHS, SHS, ST

Typical cavity wall consolidation restrained to floor joists

CHS



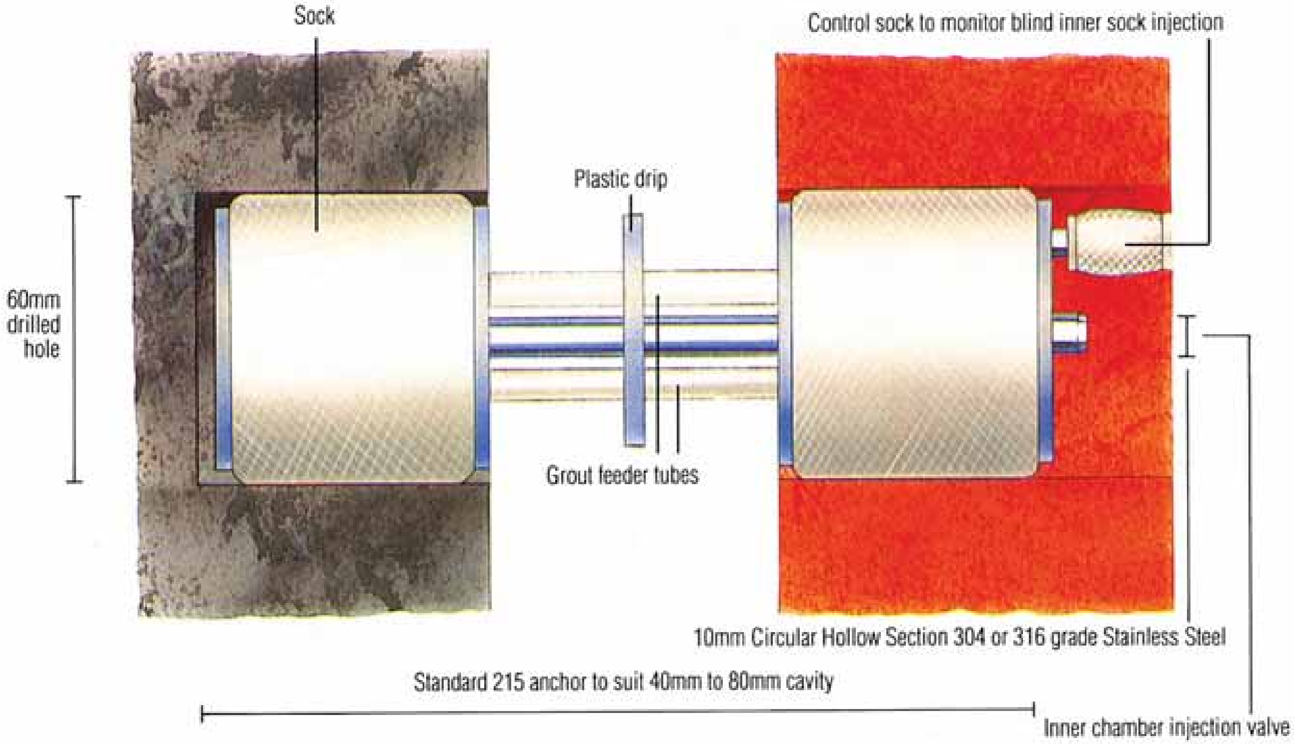
SHS/ST

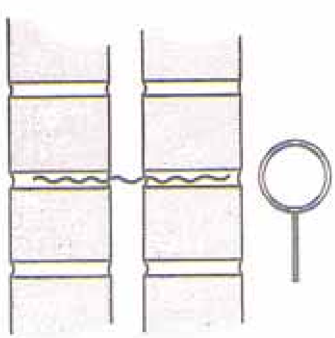


Typical Random Rubble Wall Consolidation Restrained to Floor Joist

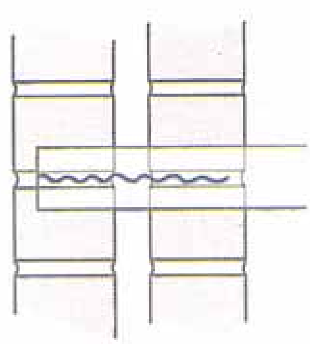
REPLACEMENT WALL TIE

TYPE RAD

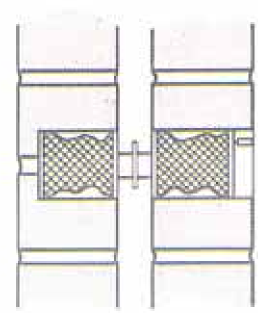




Metal detect existing tie



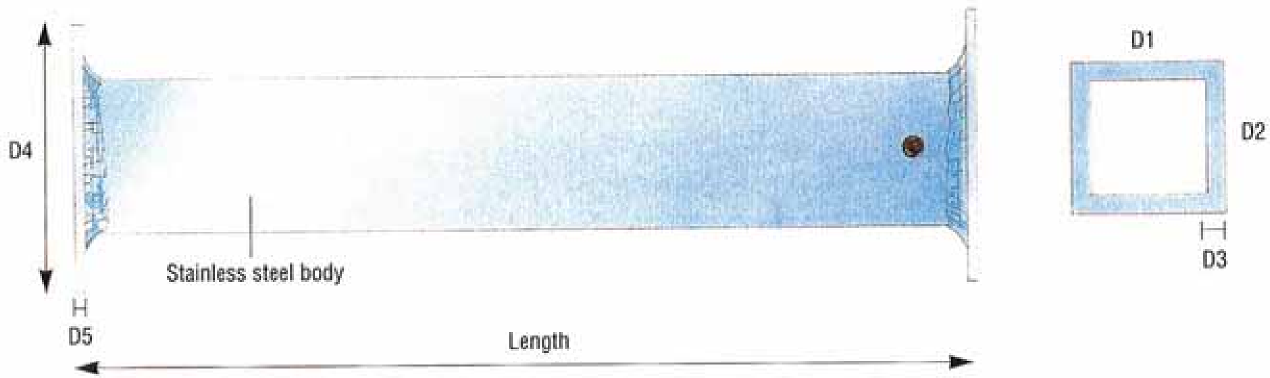
Overcore existing tie

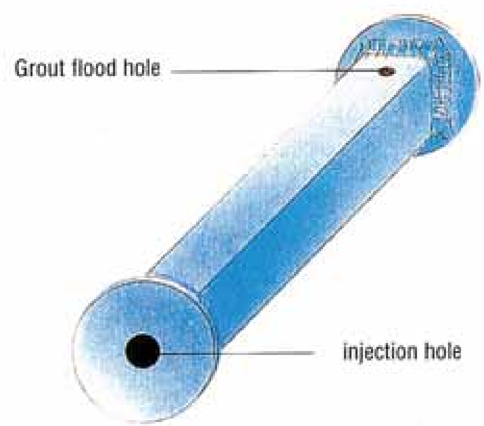


Anchor insitu prior to injection

STITCHING ANCHOR

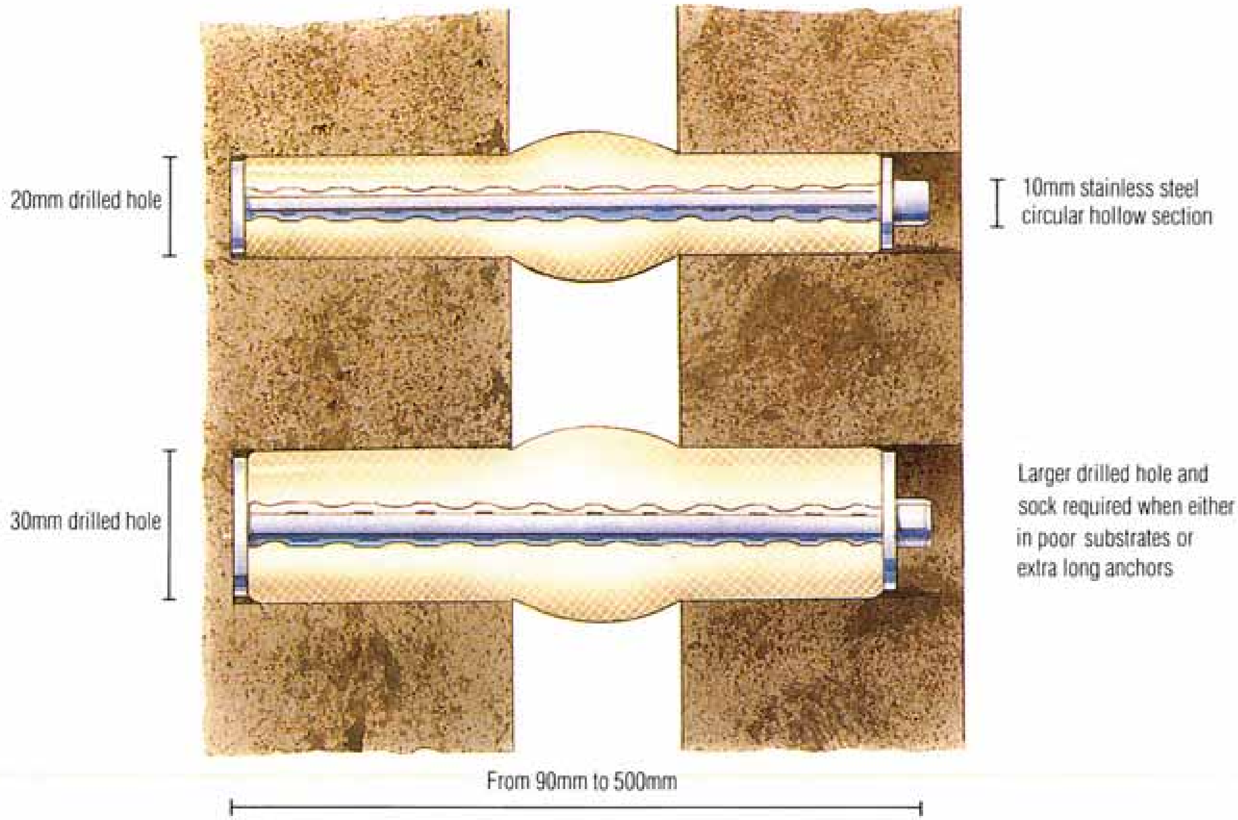
TYPE RWT & WSA

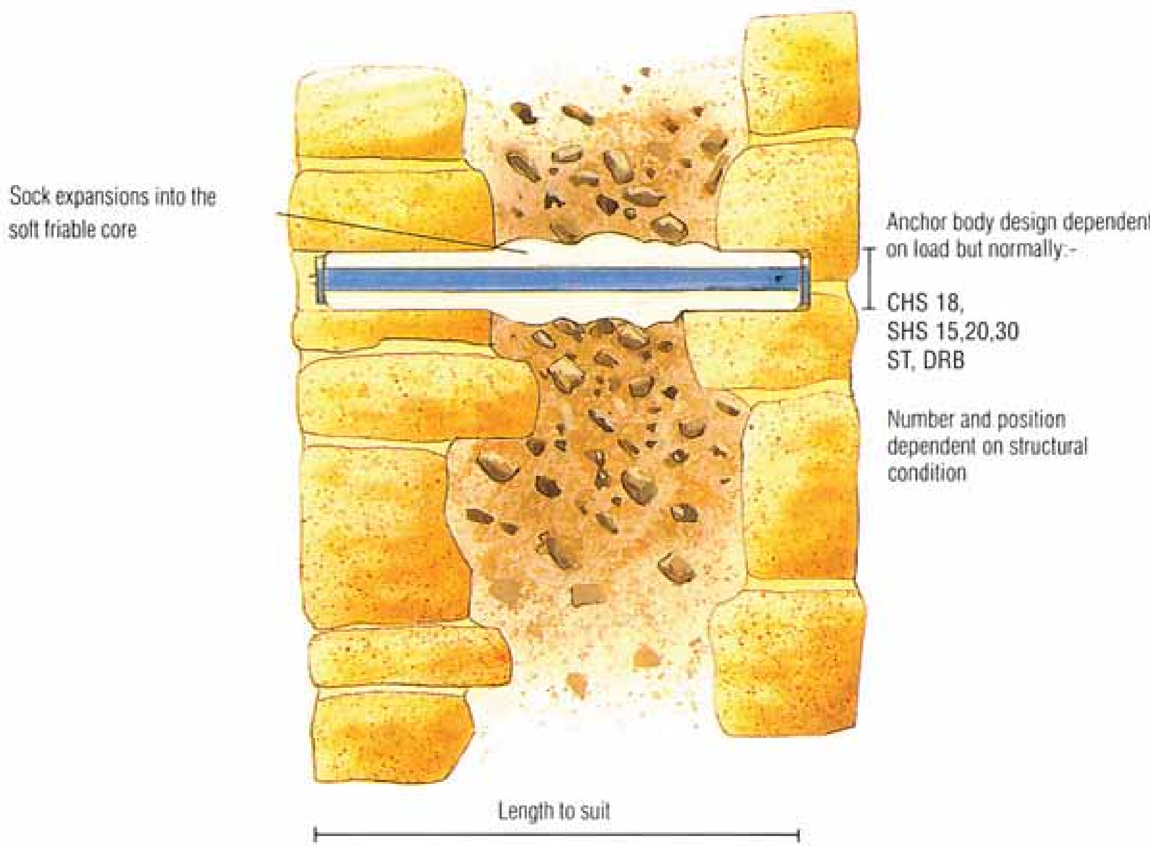




	D1	D2	D3	D4	D5	LENGTH	STANDARD DRILLED HOLE SIZE FOR GOOD SUBSTRATES
RWT 15	15mm	15mm	1.5mm	28mm	3mm	as required	30mm
RWT 20	20mm	20mm	2.0mm	36mm	3mm	as required	40mm
WSA 30	30mm	30mm	3.0mm	52mm	3-4mm	as required	60mm

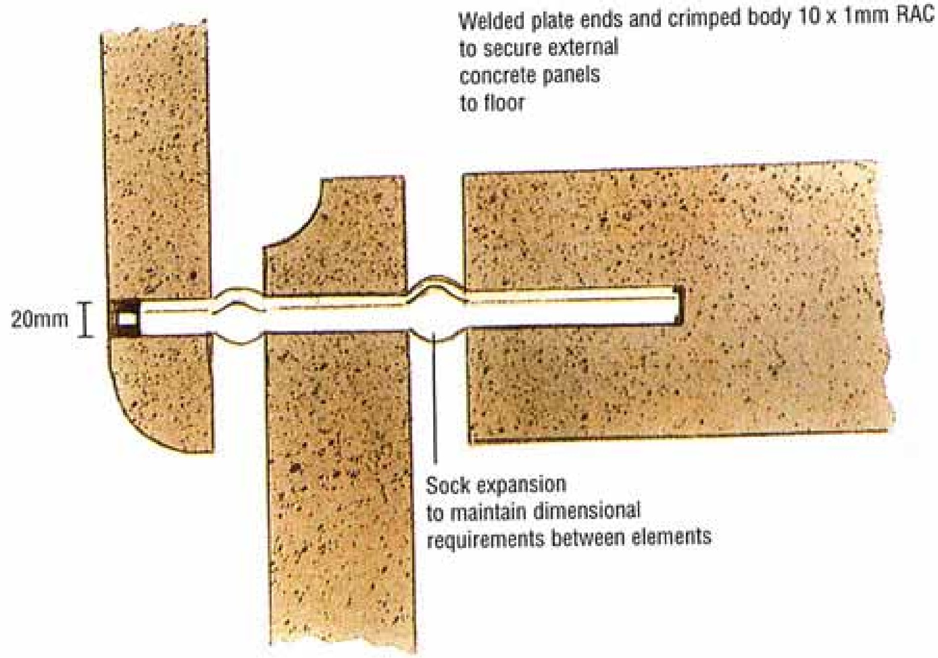
Can be used in all construction materials. Illustration indicates cavity wall, but this solution can be used in solid construction



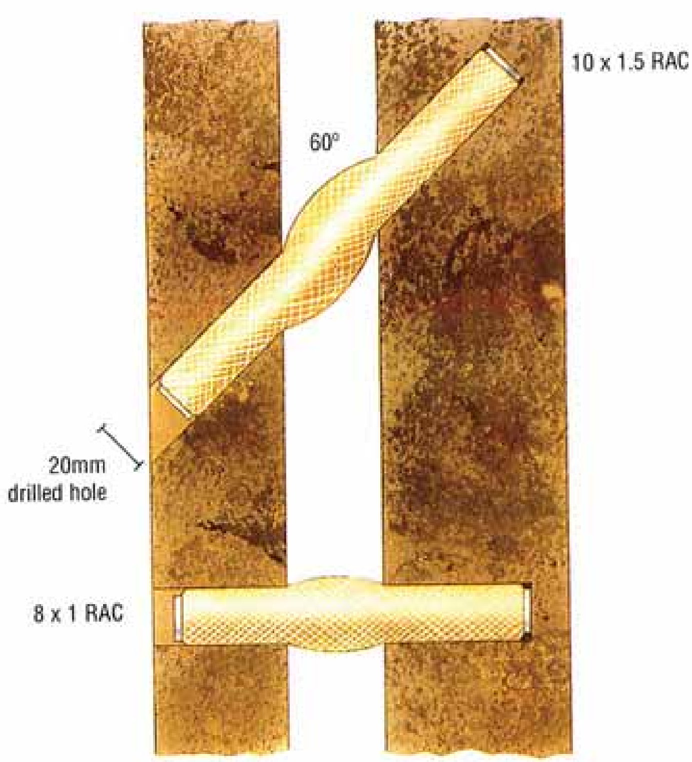


STITCHING ANCHOR

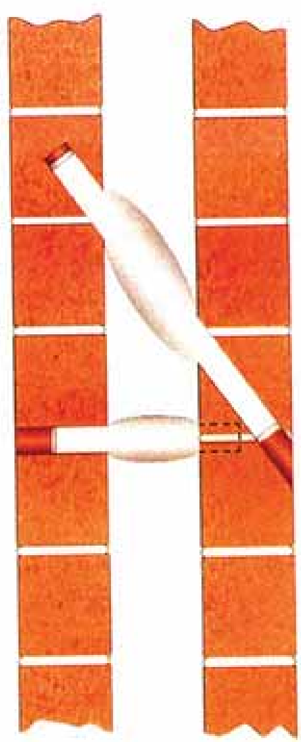
TYPE CHS



Concrete Sandwich Panel

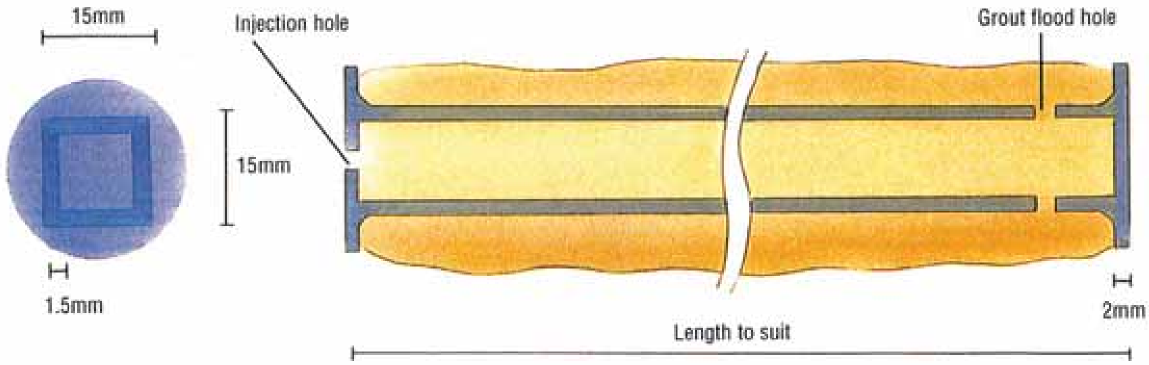


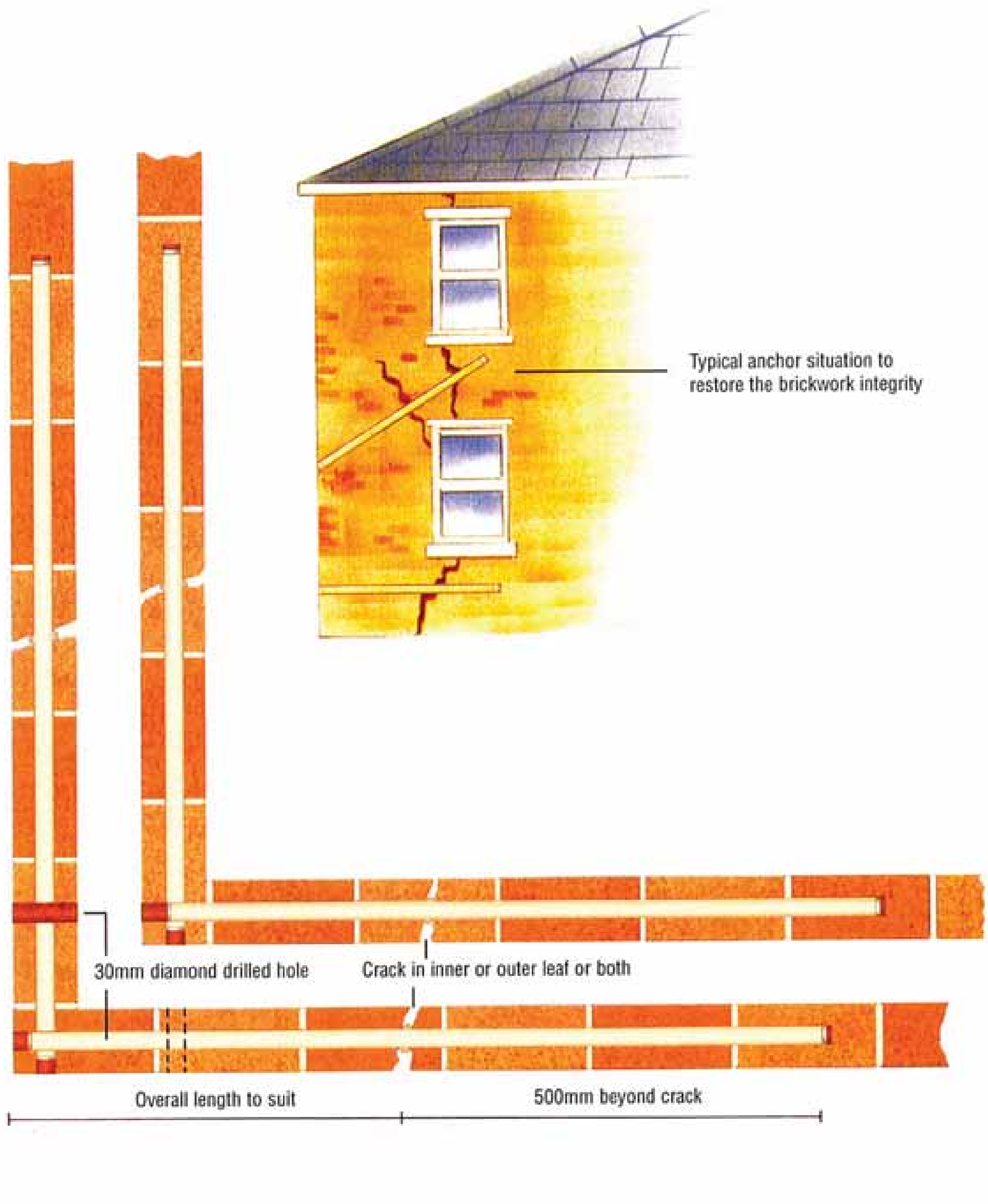
Brickwork Sandwich Panel



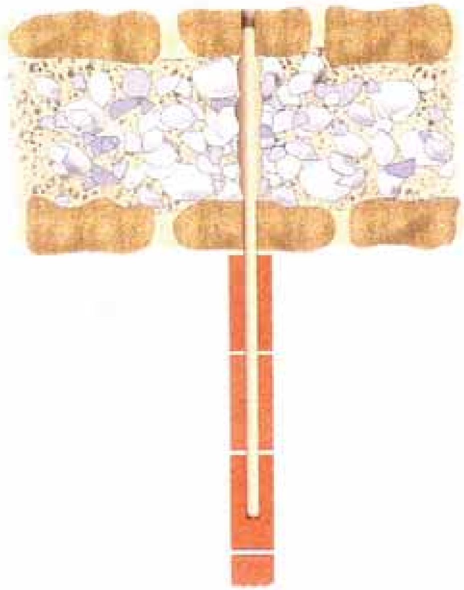
STITCHING ANCHOR APPLICATION

TYPE RWT



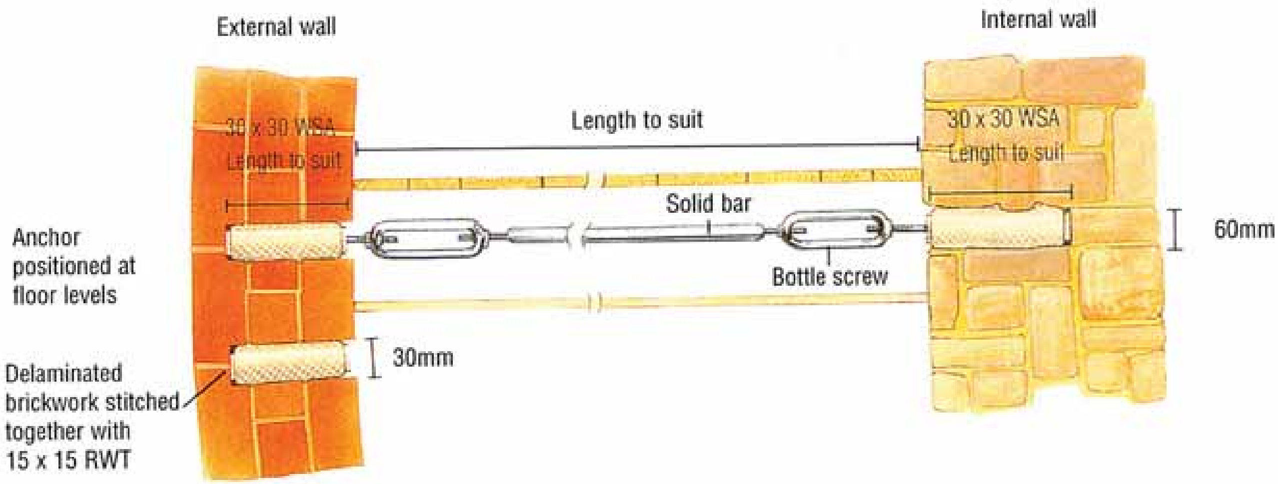


STITCHING ANCHOR APPLICATION TYPE RWT & WSA



Internal Wall Connection Detail

External wall anchored back to internal wall

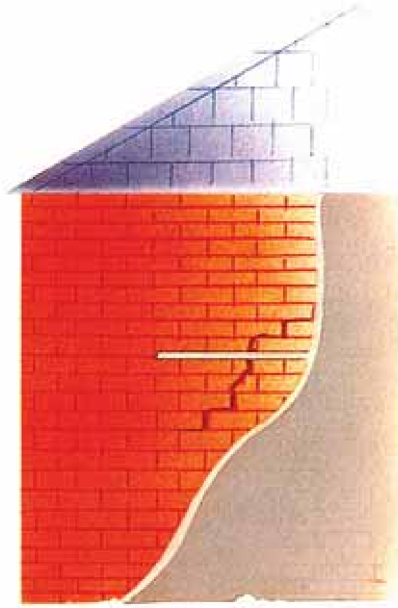


Positioned at 900 x 450 centres dependent upon wall condition

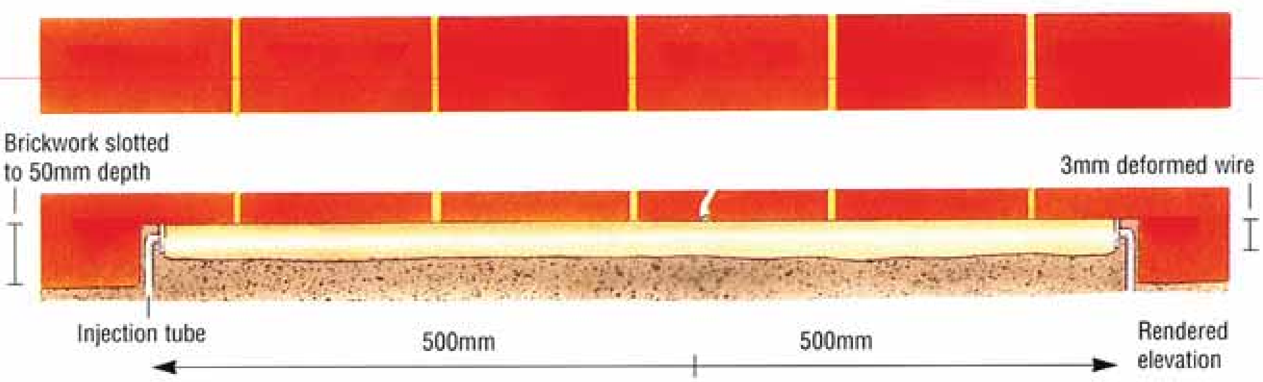
Typical anchor detail indicating the bulging and delaminating external brick wall to solid internal wall

STITCHING ANCHOR APPLICATION

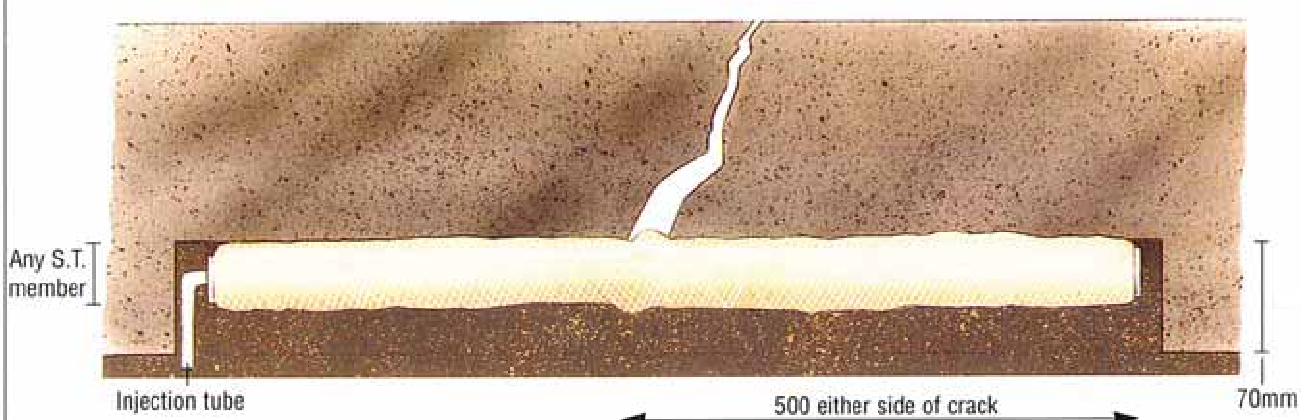
TYPE JRA



Anchor is installed sideways into wall in a slot cut using diamond or abrasive discs

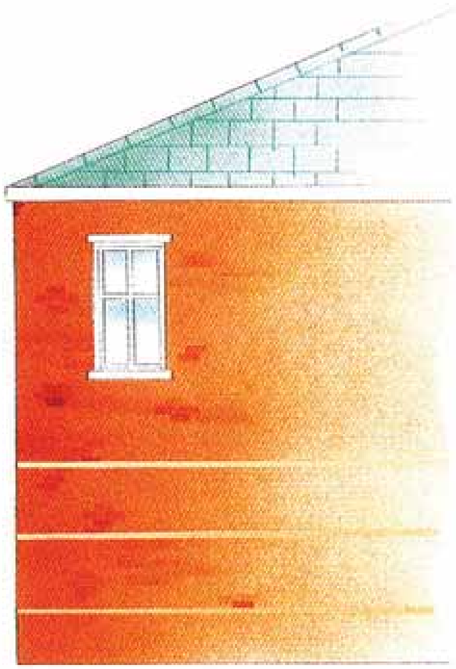


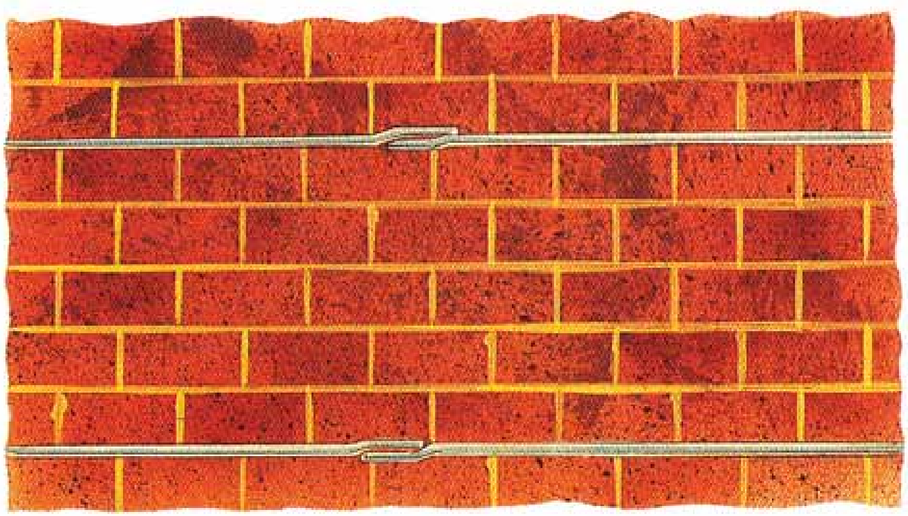
Similar design to above but no fines concrete

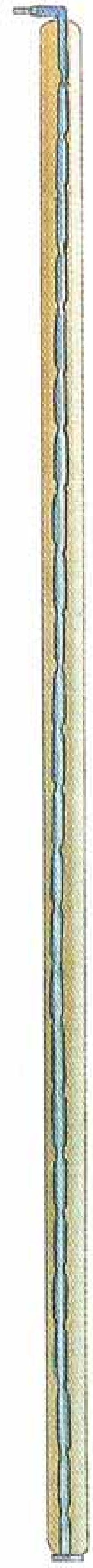


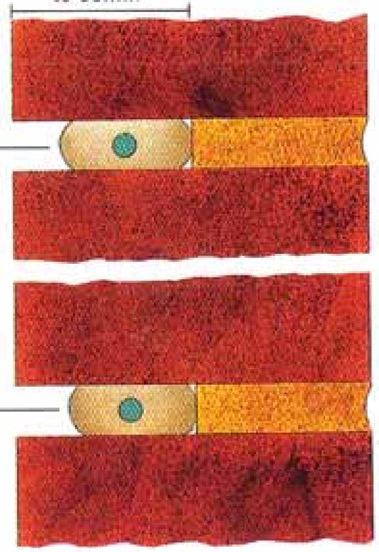
BRICK REINFORCEMENT

TYPE JRA







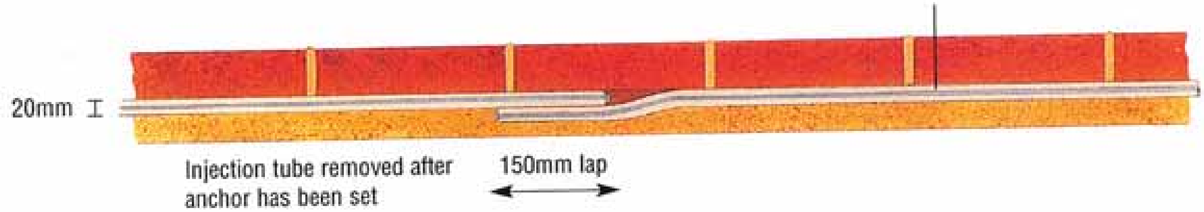


BRICK BEAM APPLICATION

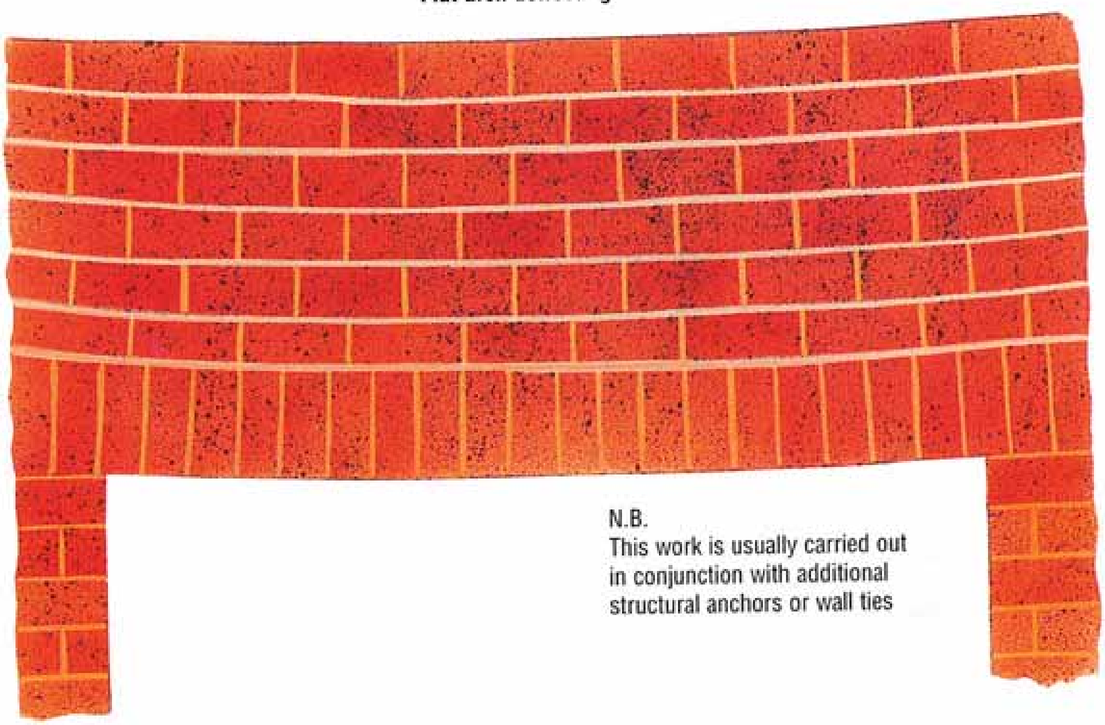
TYPE JRA

Brick joint supporting anchor

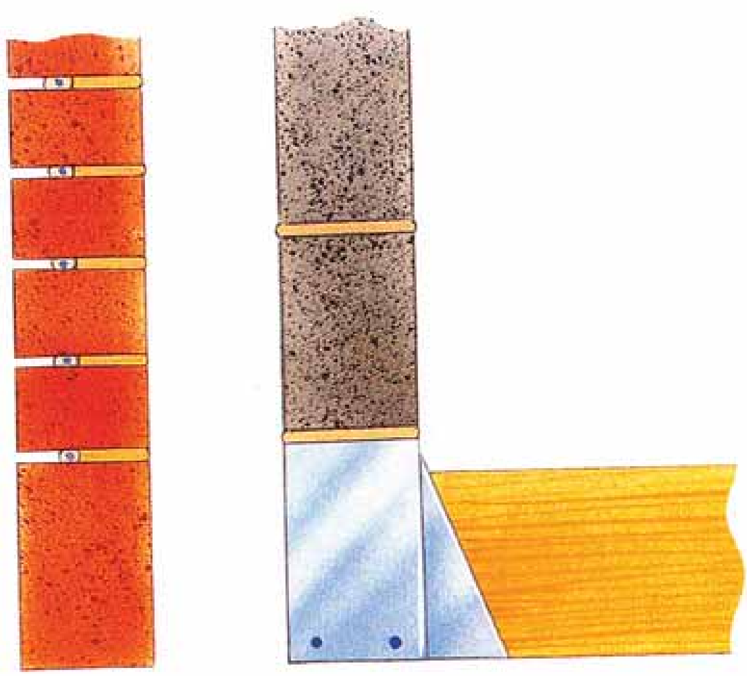
Plan



Flat arch deflecting



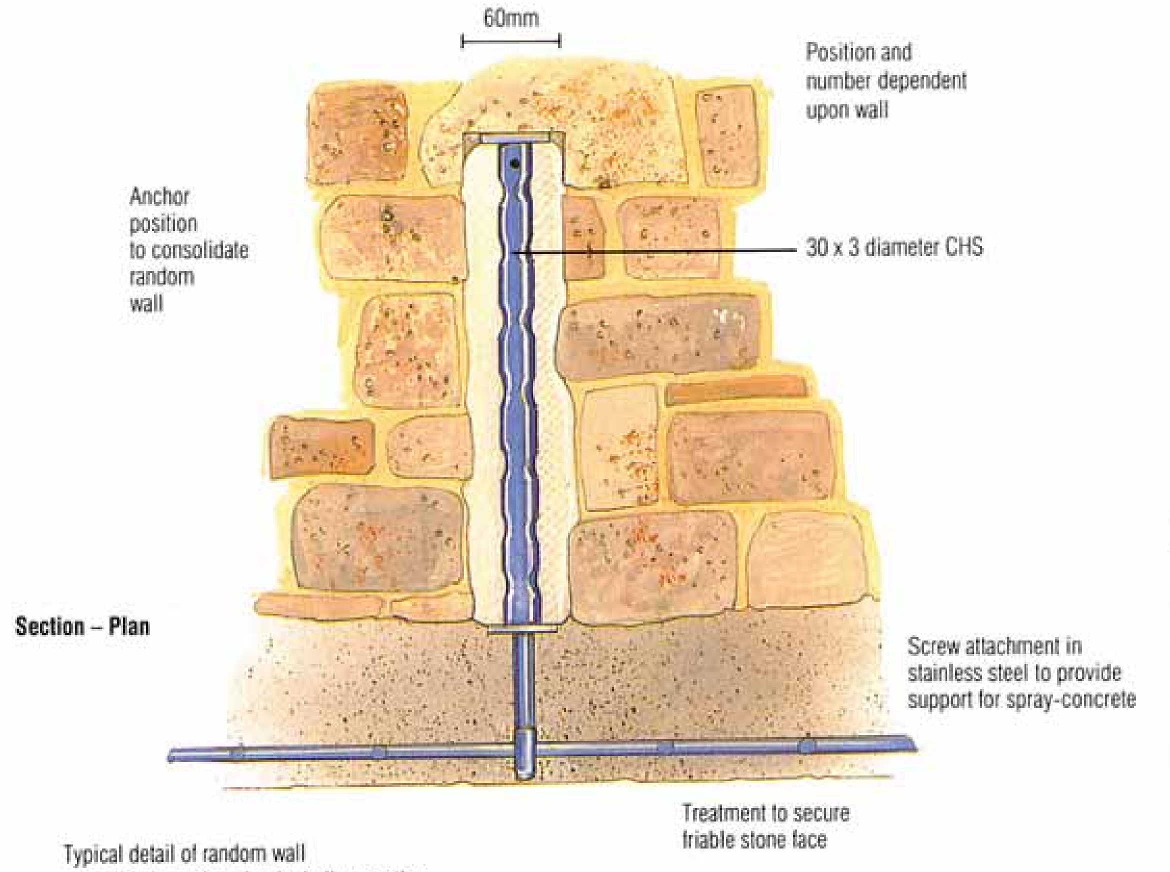
Brickwork reinforced by using remedial brick joint supporting anchor to create a brick beam



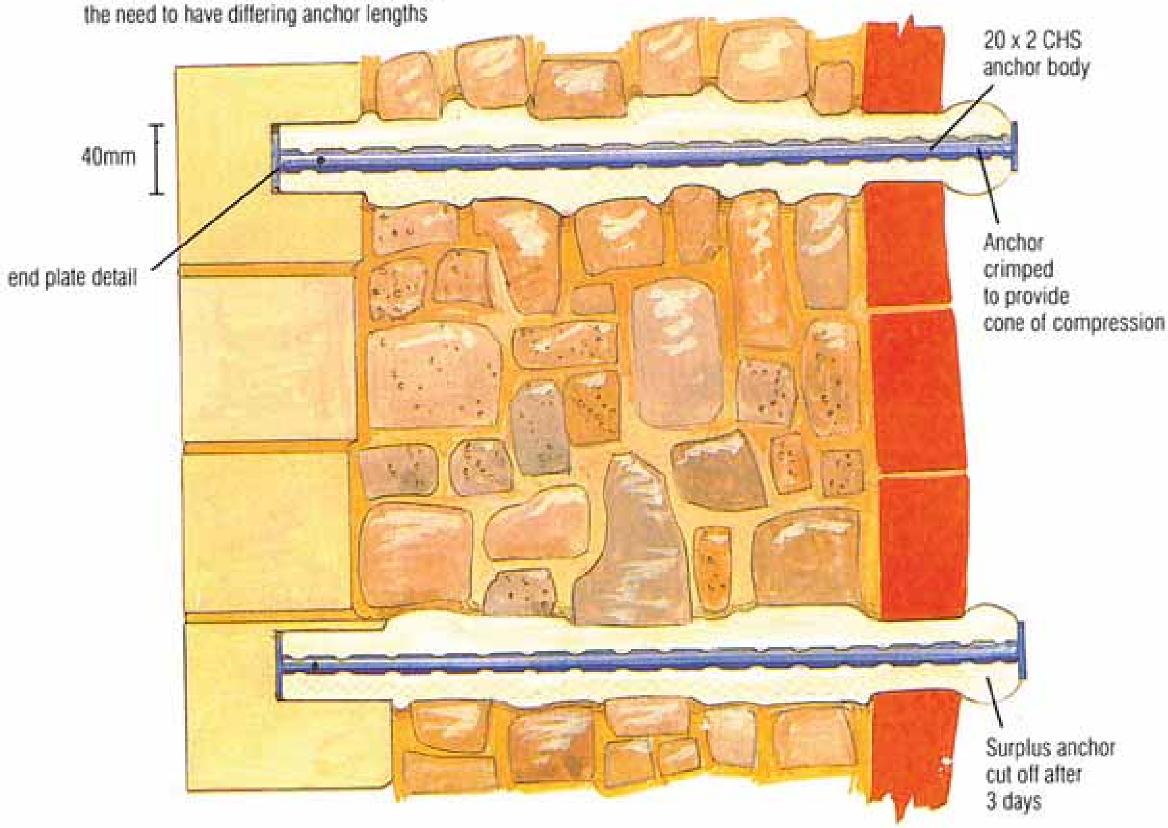
STITCHING ANCHOR APPLICATION

TYPE CHS

Typical Consolidation of Random Rubble Wall



Typical detail of random wall consolidation using circular hollow section to overcome difficulties that arise when the wall is badly deformed and avoid the need to have differing anchor lengths

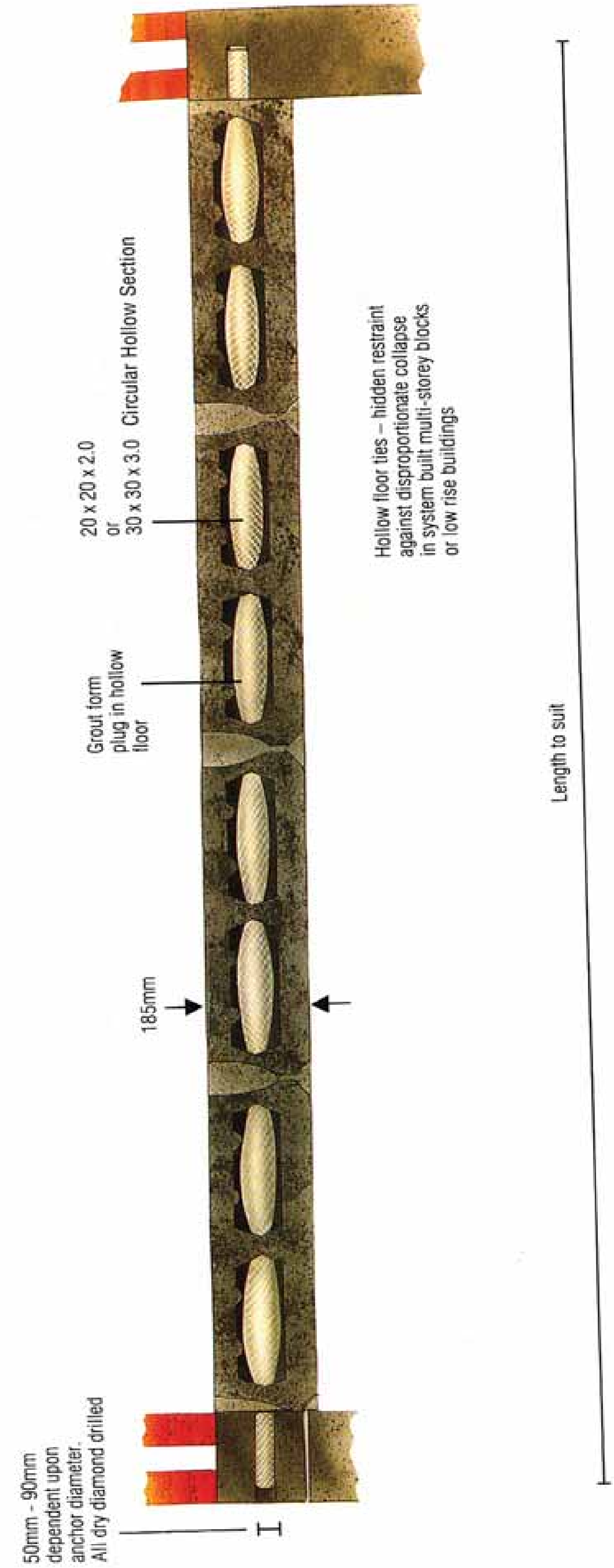


STITCHING ANCHOR HOLLOW FLOOR

TYPE SHS/CHS

Stitching Anchor – Gas Explosion Hollow Floor Ties

SECTION



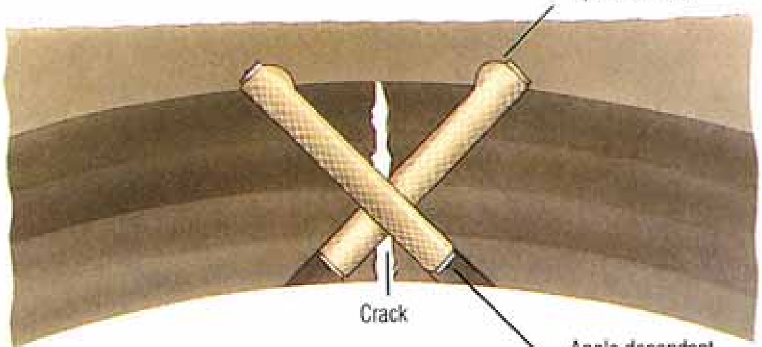
Example shows 8 metres of 20 x 20 x 2 Square hollow section

316 stainless steel

STITCHING ANCHOR APPLICATION

TYPE CHS, SHS, ST, DRB

Typical Brick Stitching Anchor
Detail to brick Arch

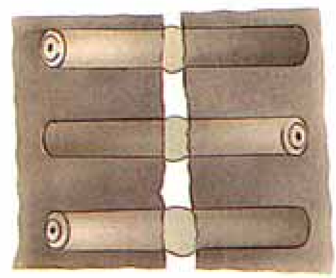


Anchor section to be either:-

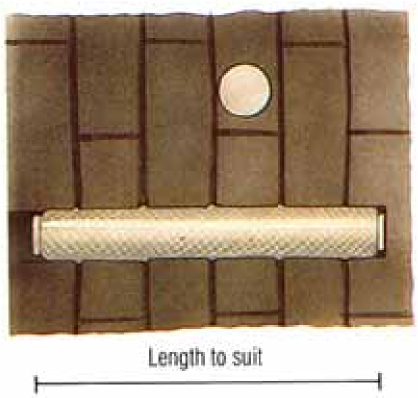
30 x 30 S.H.S. grade 304, 316
20 x 20 S.H.S.
15 x 15 S.H.S.

dependent upon load

CHS/ST20/DRB 32

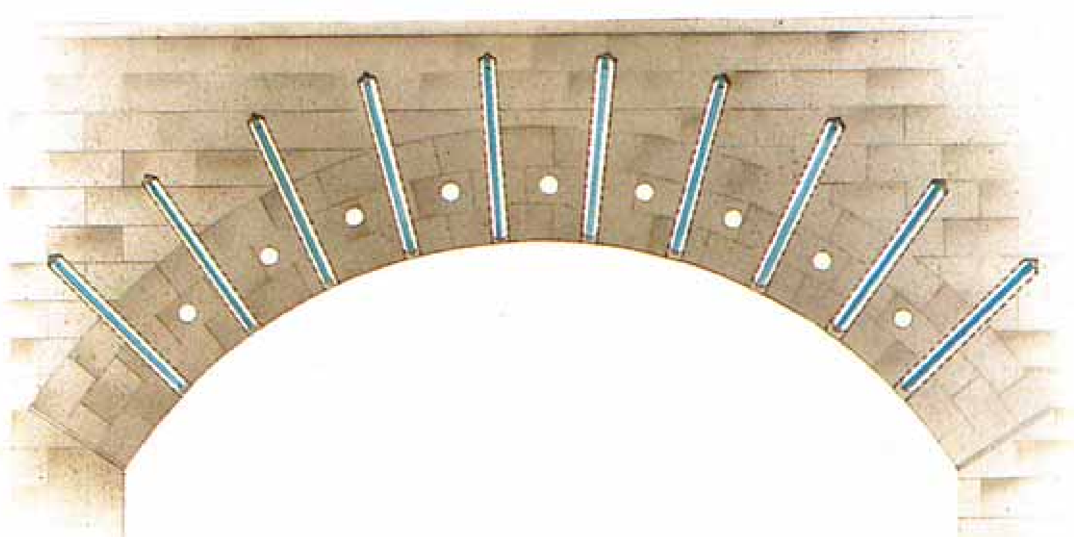


Plan View



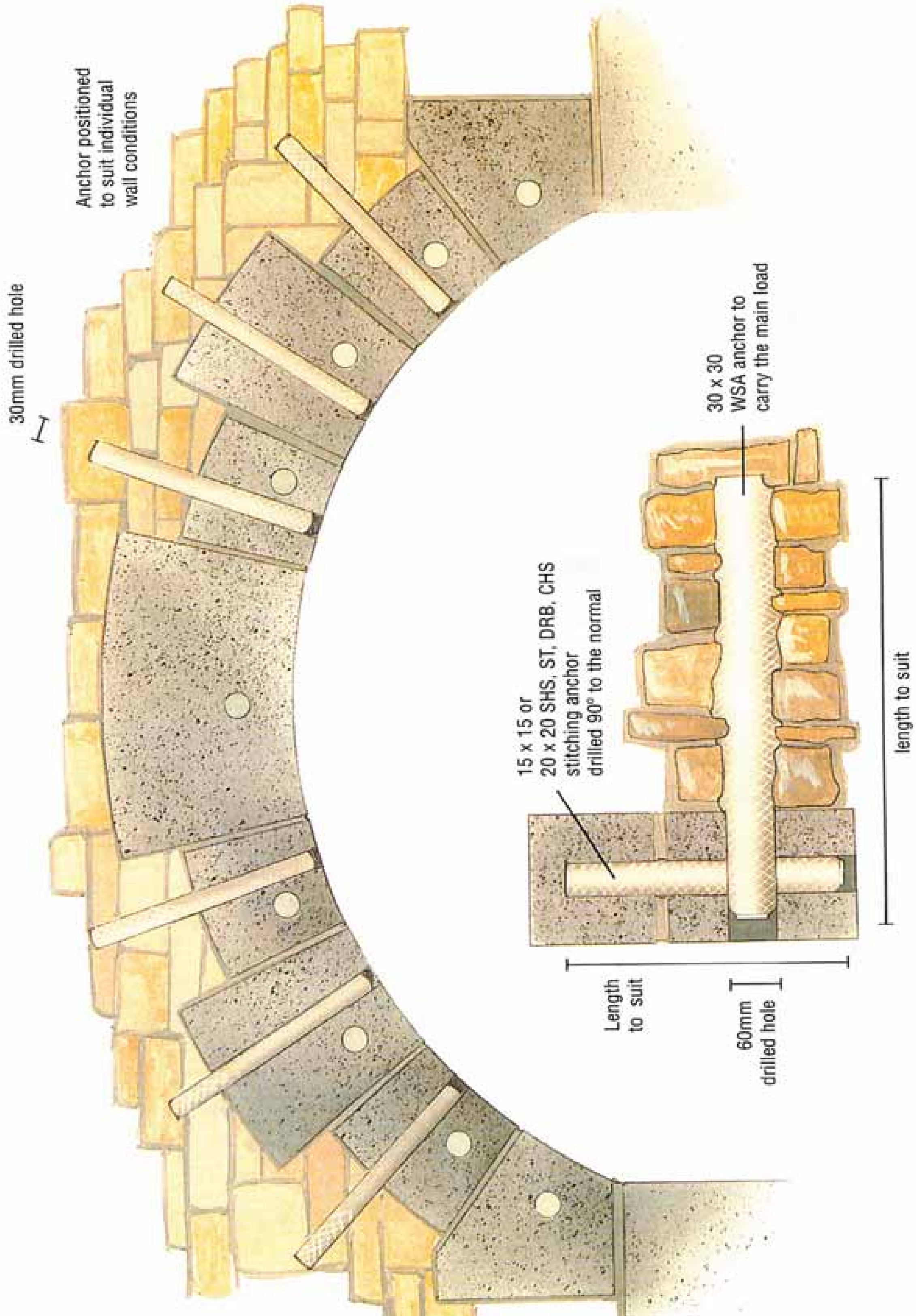
Drilled hole dependent upon anchor size

30 x 30 = 60mm
20 x 20 = 40mm
15 x 15 = 30mm



STITCHING ANCHOR APPLICATION

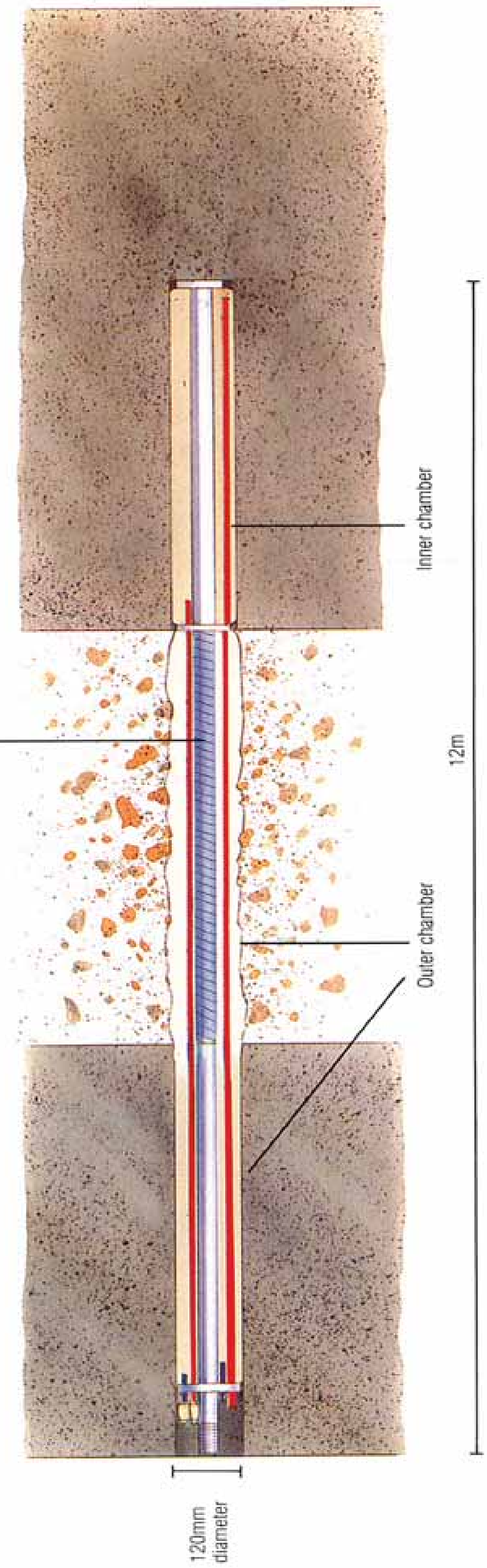
TYPE CHS



Typical Arch Consolidation

Example of Heavy Duty Anchor

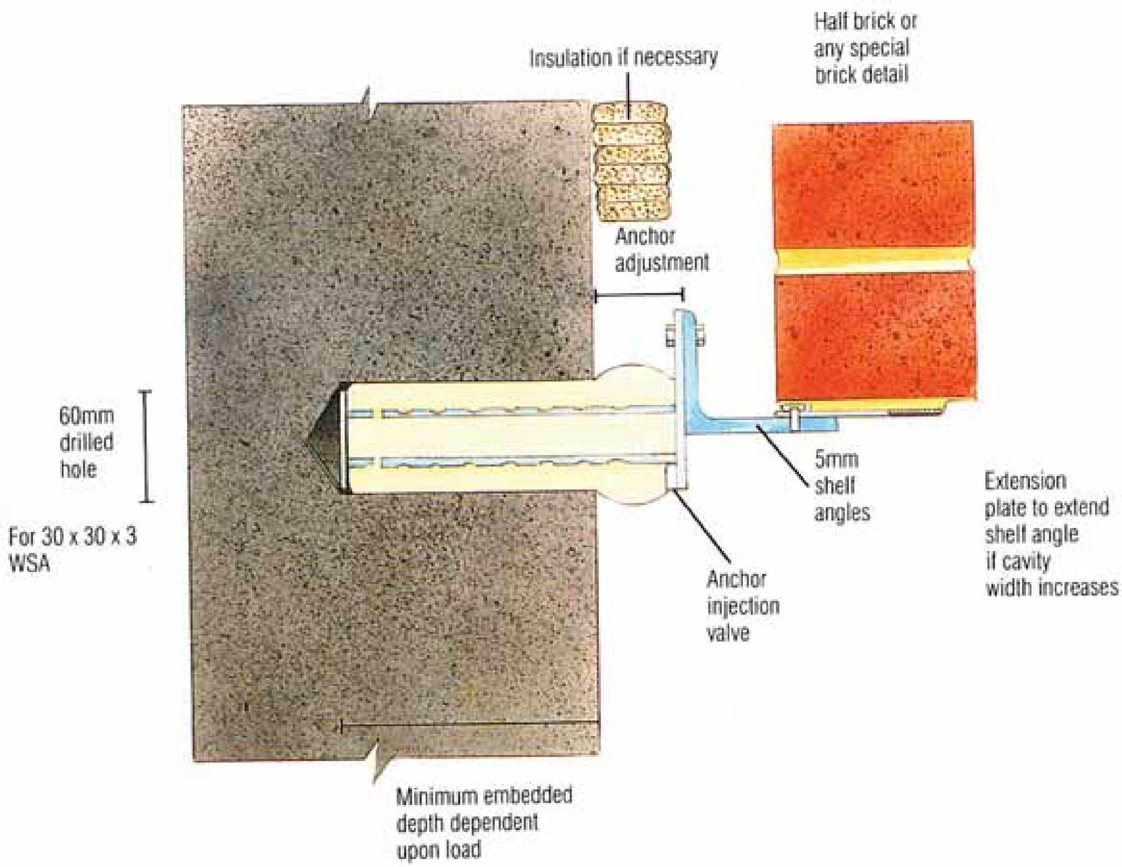
Example shows the locking of the structures in brick viaduct. The overall length and drilling diameter can be varied dependent on loads and control required

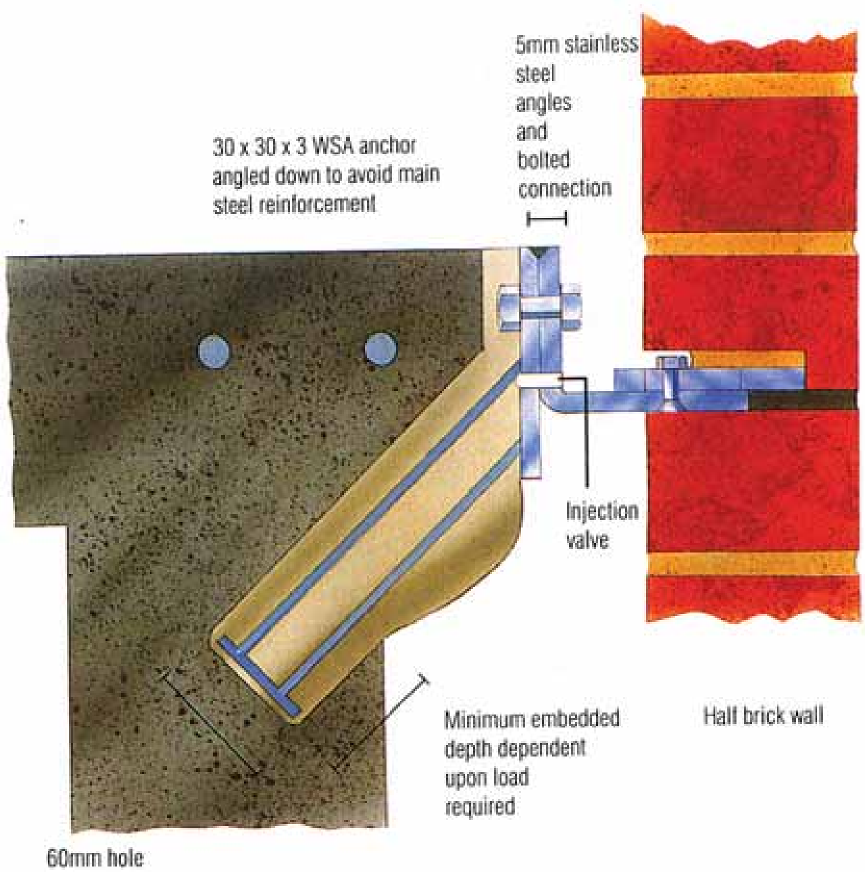


CORBEL ANCHOR WALL SUPPORTING

TYPE SHS

Brick Fascade Supporting Anchor

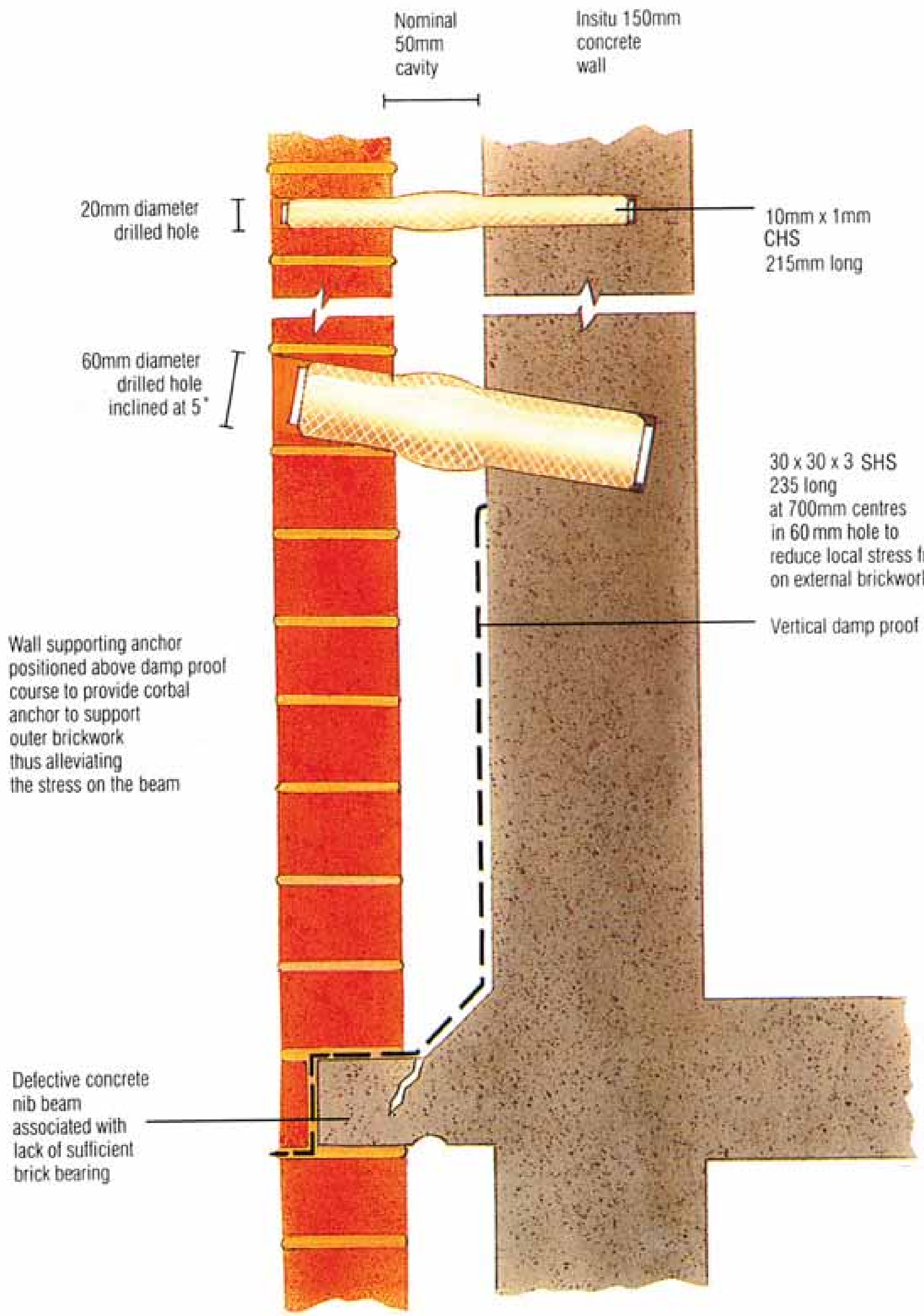




Brick Fascade Supporting Anchor

CORBEL ANCHOR

TYPE SHS

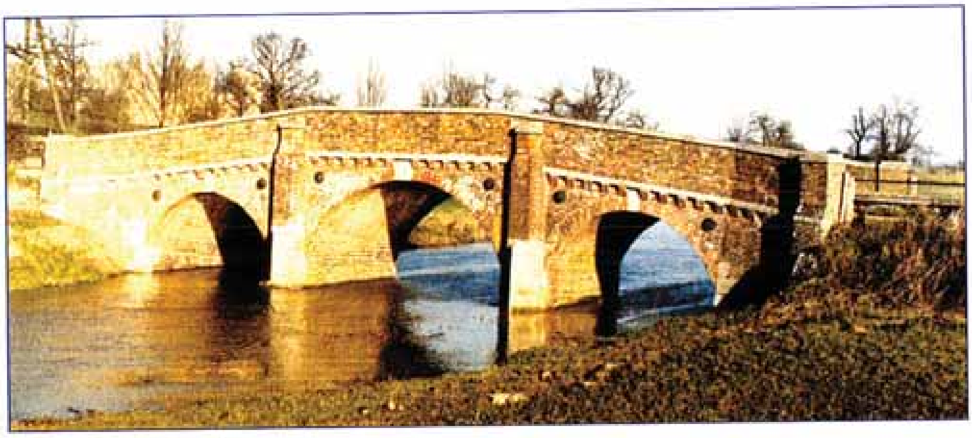


CINTEC

Case Histories

CASE HISTORY

BODIAM BRIDGE, ENGLAND, U.K.



Introduction

The Highways and Transportation Department of East Sussex County Council is responsible for the maintenance of the 200 year old brickwork arch bridge adjacent to Bodiam Castle. In recent years this has suffered from the effects of increasingly heavy traffic exacerbated by very cold winters in 1986 and 1987. This led to cracking of brickwork adjacent to the arch voussoirs, some movement in the spandrel walls and delamination of the wing walls at the south end. The County Council approached Cintec International with a view to using Cintec anchors for tying across the arch.

History

The crossing of the river Rother at Bodiam, midway between Tunbridge Wells and Hastings, has a long history. The site is that of a Roman road, constructed on a twigs and rubble causeway to serve an ironworks. Until the 13th century the surrounding alluvial plain was under a shallow depth of brackish water as much as 420m wide, and for some time crossed by a ferry. The first reference to a bridge on the site is in 1385, and the present bridge was built in 1797 for the County of Sussex by Richard Louch for £1150.

The bridge is a single track, hump-backed triple arch structure in brickwork and there are signs of various remedial works throughout its life. There appear to have been problems with the original construction for there is pronounced twist in the lower courses of brickwork towards the northern end of the bridge, which disappears as the construction continues upward. Presumably this was due to some of the timber piling settling during construction. The cast-iron end bosses of previous ties between the spandrel walls can be seen on both elevations. In 1980 an inspection carried out by divers revealed that the timber piles on which the bridge is founded had become exposed and were deteriorating. In 1982 a concrete filled Fabriform mattress was installed to provide a solid invert and protect the foundations of the bridge. Also in 1982 the approach ramps to the bridge were filled by up to 200mm to minimise the hump. A principal inspection and assessment in 1989 concluded that remedial works to the arch rings and a weight limit of 17 tonnes were required to prevent further deterioration. This weight limit remains in force after the remedial works have been completed to preserve the bridge but will still allow coaches over to visit the adjacent Bodiam Castle, a National Trust property.

Typical damage to the soffit of the bridge

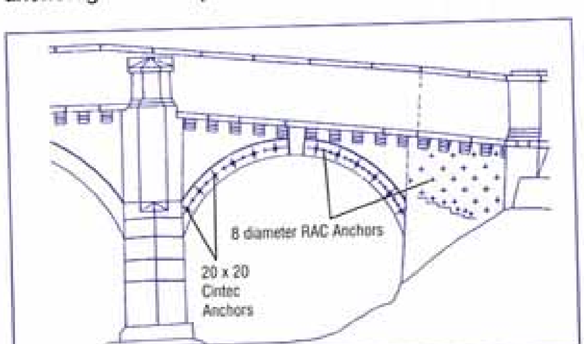
The most recent remedial work involved the repair of cracking in the brickwork. The concentration of the damage in the two side spans of the three span bridge suggested that the initial cause was possibly impact loading towards the ends of the bridge before the 'hump' was levelled out in 1982. This impact loading will have had the effect of forcing out the spandrel walls. Frost damage during the cold winters of 1986 and 1987 and washing out of mortar have further developed the initial effects. This has led to cracking of brickwork adjacent to the arch voussoirs, some movement in the spandrel walls, and delamination of the wing walls at the south end.

In view of the historical context of this attractive small bridge, East Sussex County Council was concerned to find an effective means of tying, with 11 minimum visual impact, across the arches, within the thickness of the arch brickwork, Cintec anchors offered the possibility of bonding along the full length of the anchor without an unsightly external anchorage or problems with grout losses through the cracks in the arch.

The use of Cintec anchors for Bodiam bridge gives a number of major advantages over conventional cement

Placing the anchor in the prepared hole

or resin grouted anchors. Conventional grouted anchor systems can have problems in the grouting, and there are doubts about the effectiveness of the anchors, when large volumes of grout are lost into voids within the structure, or escape through cracks. Bodiam bridge, with its cracking and deteriorating joints, provides a good example of the potential problems. But in the case of Cintec anchors the sleeve limits the travel of the grout and ensures that the holes are filled and effectively bonded to the parent material. This capacity to constrain the grout can be used to tailor the anchor to the material in which it is to be placed. For maximum bond in weak or voided materials, a generous sized sleeve of relatively flexible composition can be used with lower grout pressures. In stronger and more homogeneous parent material, a smaller diameter and stiffer sleeve allows higher grout pressures for longer anchor lengths, more economy in grout use and probably greater direct bond. With conventional anchor systems the gap between the tension element and the inner face of the drill hole has to be kept to a minimum to ensure that the hole is completely filled. With a Cintec anchor the diameter of the drill hole is normally between two and three times the nominal size of the structural section (and could be still greater) giving a much larger bond area. This is particularly beneficial in weak materials where the low bond stresses combined with the bonding agent maximise the anchorage into the parent material.



Part elevation of the bridge and abutment showing anchor locations

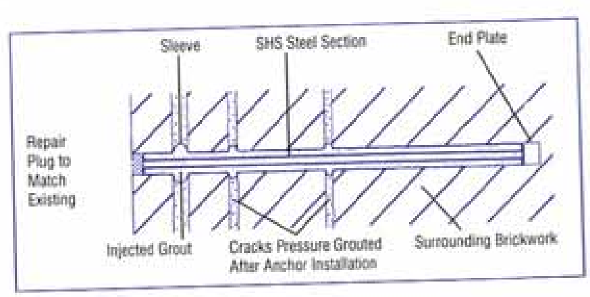
With this flexibility it is possible to use the Cintec system for lengths in excess of five metres, several times the limiting length for some similar systems. The length capability is also a result of using structural hollow sections which can double as the grout tube. This guarantees grout injection at the bottom of the hole without grout tubes and gives confidence that the sleeve is effectively filled. Since the anchors are bonded throughout their length it is quite feasible to stop them behind the exposed face and make good the drill hole with coloured mortar or a slip taken from one of the cores.

The solution

To prevent any further spreading of the arches it was proposed to tie across the full width of the bridge. The main anchors are 20 x 20 x 2.0 SHS with the lengths, of 2.0m and 1.0m, staggered from both sides of the bridge. This ensures that the lateral stresses are not transferred to a single plane nearer the centre-line of the bridge causing new cracking at this point. Strengthening of the local edge damage to the brickwork of the arches is achieved with the installation of 450mm long RAC anchors formed with 8 x 1.5mm circular hollow sections. The interspacing of the two anchors allowed the 20mm diameter holes for the small anchors to be used for the fixing of the stand used with the diamond drilling of the 52mm holes for the main anchors, thus keeping the making good to a minimum. Following grouting of the anchors the holes were made good with coloured mortar to match the brickwork.

The smaller anchors were also used for repair of the southern wing walls where core drilling of bulged portions of the wall showed that a half brick facing skin was delaminating from the full 600mm thickness of the wall. The high bond capacity meant that an effective anchorage into a single half-brick skin could be achieved while still having the end of the anchor recessed into the face. Once this skin had been tied back the cavity was grouted to stabilise the bulged area.

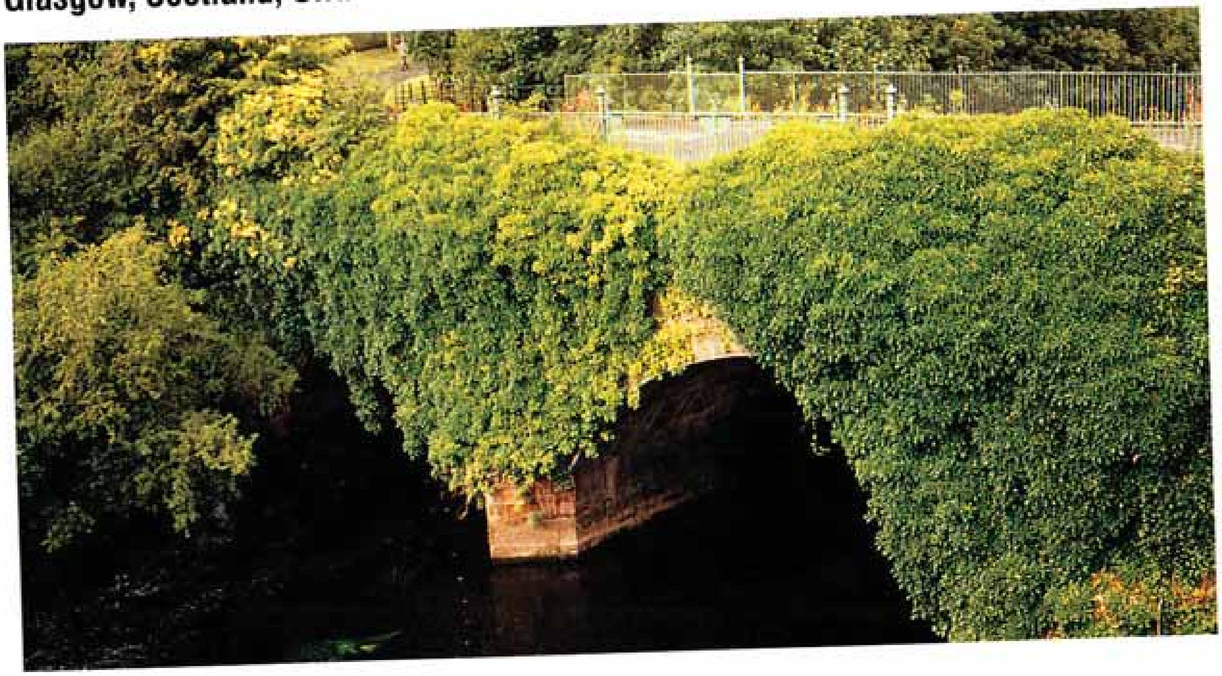
To complete all the repair work the cracks were surface sealed and grouted with resinous or cementitious grout depending on their width. Brickwork was re-pointed and repaired where this was essential, but this was kept to a minimum because of the difficulty of matching the existing finishes.



Section through a typical Cintec anchor installation

CASE HISTORY

Snowbridge
Glasgow, Scotland, U.K.



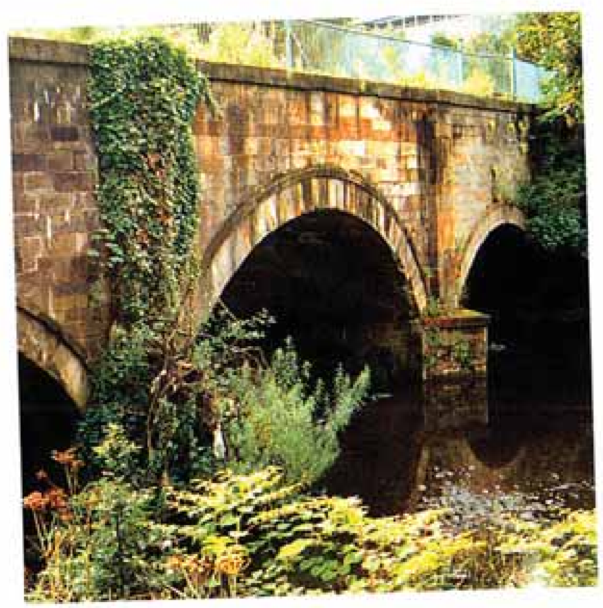
Hidden in the tranquil gardens of Kelvin Grove Park Glasgow, Scotland. The Snowbridge was thought by many to have gracefully retired into obscurity. Its past glory of being the main means of disposing of the accumulated snow from the entire main thoroughfares of Glasgow had been superseded decades before by mechanical loaders.

With its retirement, it suffered like most obsolete structures with neglect and lack of maintenance due to the low priority it rated in the financial bids.

In 1987, Cintec was asked to provide an estimate to rectify the many years of neglect. Following a complete survey and report from Engineers Ove Arup and Partners, a comprehensive maintenance and anchoring scheme was presented to the City Council to bring the structure to a safe condition.

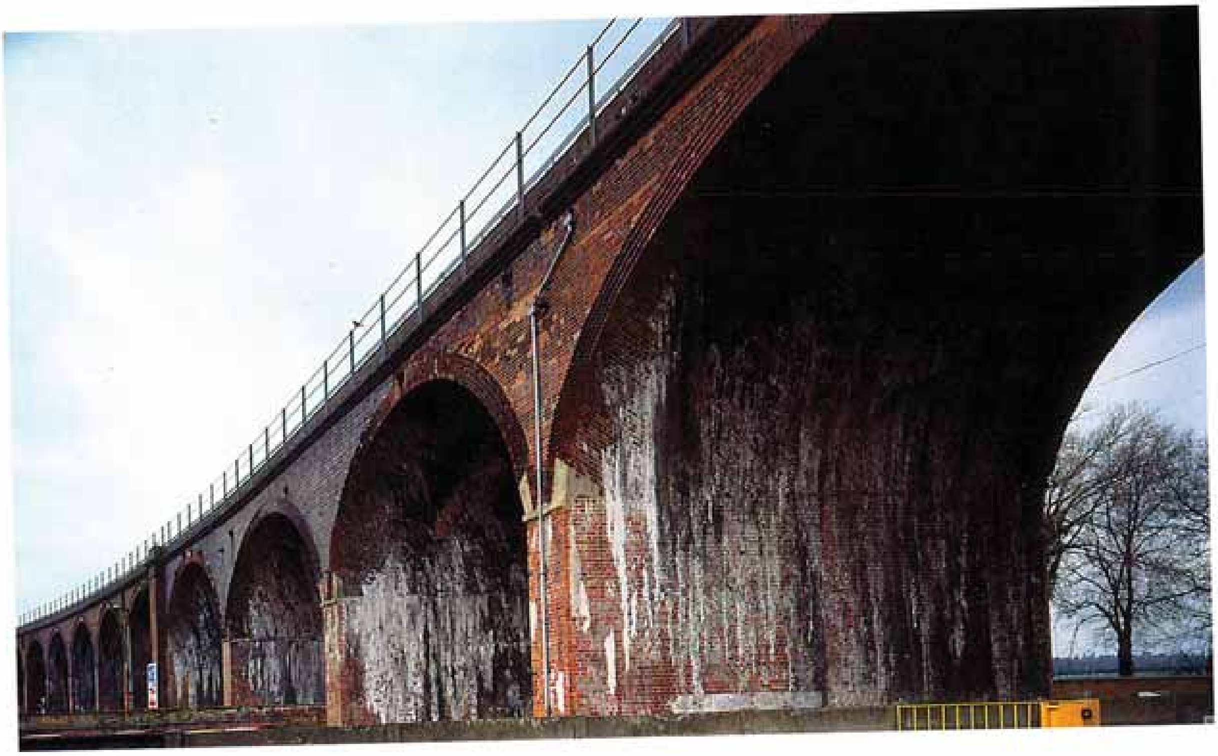
The scheme principally provided for the introduction of square hollow section stainless steel anchors size 30x30x3, 20x20x2, 15x15x1.5 in lengths from 500mm to 5000mm to the voussoirs and intrados of the arches and spandrel walls. The drilling chosen was wet diamond drilling with core retention to the natural stone structure. This provided the desired drilling accuracy and the need to reduce the vibration to a minimum in the fragile structure.

The proposals where kept in abeyance for several years before work commenced. Indeed, serious consideration was given to demolish the whole structure until it was found to contain optical telecommunications between the UK and the U.S.A.



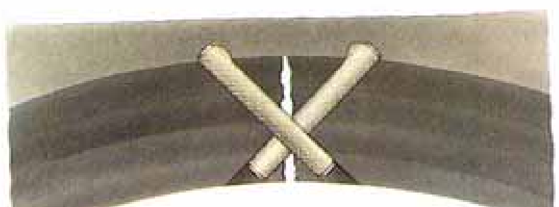
CASE HISTORY

WORCESTER VIADUCT



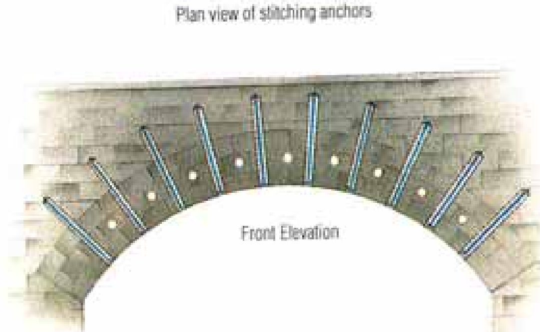
Worcester Viaduct comprises sixty-five brickwork arches rising from approximately two storey height near the railway station to over three storey height as it approaches the river. Lack of proper draining within the arch had led to the spandrel walls being forced away from the intrados arch with longitudinal cracks close to the longitudinal edges of the bridge. Water penetration had contributed to cracking at the springings of some spans and delamination of external parts of some columns. These problems had been exacerbated by weathering, particularly freezing and thawing. Previous efforts to restore the structural integrity were evident, but had proved ineffective.

Transverse 30 x 30 x 3 SHS stainless steel WSA anchors were installed to restore the integrity of the spandrel wall/intrados arch connection at approximately 750mm centre-to-centre and alternate lengths of 2.0m and 2.5m. Stitching anchors were angled across the longitudinal cracks to restore structural integrity and the cracks were then filled. Transverse and diagonal stitching anchors, type RWT, 15 x 15 x 1.5 SHS stainless steel, were installed to restore the strength of the delaminated columns and the cracks filled. Drainage holes were drilled through the intrados and plastic pipes were installed to help relieve the existing water pressure. To date five spans have been renovated using the Cintec system and further spans will be renovated as part of an ongoing maintenance programme.



Section through arch

Plan view of stitching anchors



Front Elevation

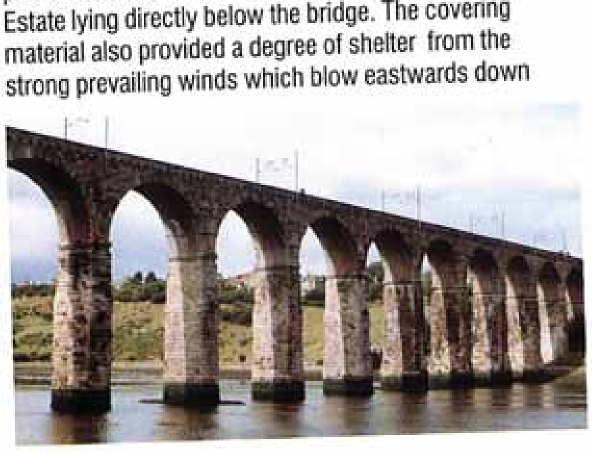
CASE HISTORY

ROYAL BORDER BRIDGE, ENGLAND, U.K.

Royal Border Bridge, carrying London -Edinburgh mainline train. Photo : Mel Holley ©

As part of Railtrack's major programme of repair and refurbishment of the land-based arches, work was authorised on numbers 1–15 of the Royal Border Railway Bridge. The bridge carries the main Inter-City East Coast rail line between Edinburgh (Waverley Street) and London (King's Cross). George Stephenson's magnificent 28-arch, 128 feet high viaduct spans the tidal estuary of the River Tweed between Berwick and Tweedmouth, two and a half miles south of the Anglo-Scottish border. Queen Victoria and Prince Albert opened the 2160 feet long bridge in 1850; the structure will celebrate its 150th Anniversary at the Millennium. The project was complicated by both environmental and technical factors.

Green nylon based Debri-Mesh surrounded the main work areas to contain dust and debris from the drilling which, if uncontained, would cause environmental problems to the residents of the 36-house Riverdene Estate lying directly below the bridge. The covering material also provided a degree of shelter from the strong prevailing winds which blow eastwards down



the Tweed River valley. Furthermore, certain areas of the 61' 6" span brick arches provided roosting areas for galleries of bats and, because they are a "protected species", provision had to be made to keep their exits clear with minimum disturbance to the bats' areas. The ornamental stone-work which forms the top parapet of the viaduct, is also a nesting site for House Martins; also, in 1996 a pair of Kestrels were observed nesting under one of the electricity catenary poles.

CASE HISTORY

ROYAL BORDER BRIDGE, ENGLAND, U.K.

ANCHOR DESIGN

About 60 men were employed on the repair work and, to minimise the noise associated with work on a scaffolded structure, drilling and the movement of heavy vehicles delivering materials, the contractors were obliged to limit their work to between 8 am and 5 pm.

The project required the installation of 1256 Cintec anchors spread over 15 arches; the project was carried out during 1995 and 1996. The first stage dealt with the northern based arches which cross the River near Berwick Railway Station which is built on the site of the old castle. To enable the second stage of the repairs, an intricate network of scaffolding supported wooden staging boards from ground level to the top of the bridge (126 feet). The size of the undertaking can be gauged by the amount of steel scaffolding tubes required which, if laid end to end, would cover 65 miles.

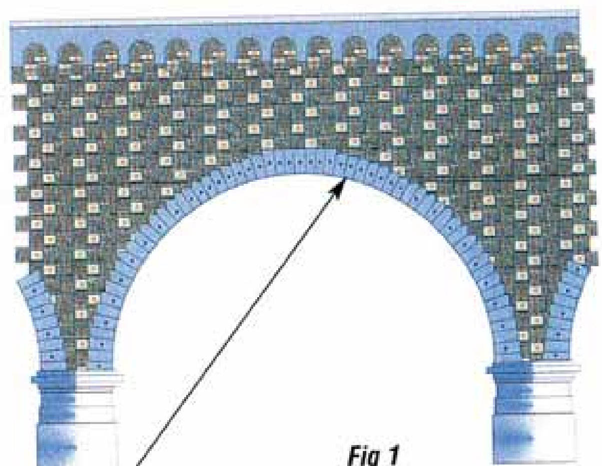


Fig 1

The Cintec anchors (see figs 1 & 2) were installed horizontally through the voussoirs to varying sizes and drilled depth in order to prevent the problem of creating a shear line in the parent material.

The project was partly funded by English Heritage. Apart from the erection of the electrification gantries and cables on the high-speed 125 Inter-City expresses some years earlier, this refurbishment is the first major repair work to be carried out to the Royal Border Bridge for over nearly 150 years – a tribute to the engineering skills of the Victorian builders and also an indication of the faith now placed in the Cintec Anchor System.

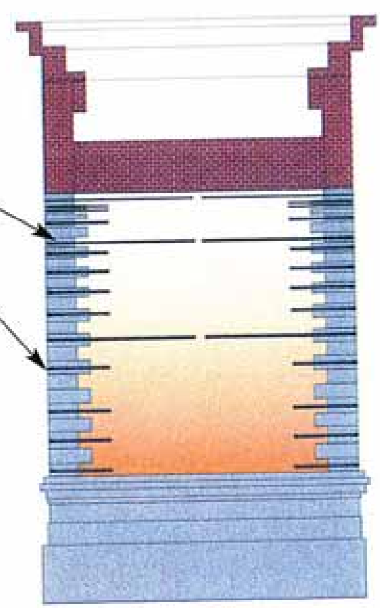


Fig 2

CASE HISTORY

TERMINAL TOWER, CLEVELAND, OHIO, USA

This imposing building, was once the main rail Terminus for Cleveland. It is a most significant landmark. When it was built, as part of the Van Sweringen brothers' Union Terminal, it was the tallest building outside of New York City until 1967 when Boston's Prudential Centre was built; the original design of the Terminal lacked the tower. Terminal Tower remains the second tallest building in Cleveland and Ohio, and has recently been refurbished for use as a prime commercial centre. The centre includes some of the finest shops, offices and restaurants in the City.

As part of the refurbishment, parts of the masonry were in need of radical repair; Cintec was contacted. Following an inspection by the project engineers, repairs to the masonry were carried out at the same time as the contractor was inspecting the masonry from a swing stage. Cintec Anchors Type RAC with a single sock 12" (300mm) long and double sock anchors $17\frac{3}{4}$" (450mm) long with a 4" (100mm) sock at each end were inserted into $\frac{3}{4}$" (20mm) diameter holes and inflated using grout filled cartridges and a caulking gun. RWT $\frac{5}{8}$"x$\frac{5}{8}$"x$29\frac{1}{2}$" (15x15x750mm) anchors were used to stitch the soffit stone at the upper band course.

Engineers
Webster Engineering Associates, Cleveland, Ohio, USA

Contractors
M.A. Building & Maintenance Co., Cleveland, Ohio, USA

CASE HISTORY

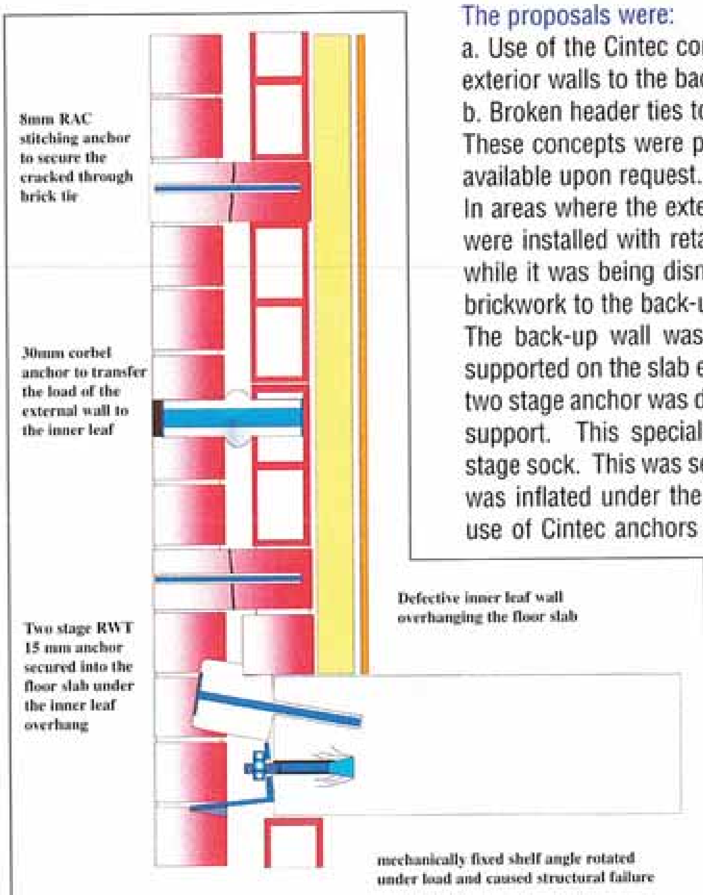
77 HOWARD STREET, TORONTO, ONTARIO, CANADA

Exterior wall restoration

This 24-storey apartment block's exterior wall consists of two wythes tied together by courses of header bricks. The exterior wythe is a glazed clay brick and is supported by a painted steel shelf angle connected at each floor into the floor slab. The inner wythe consisted of a 4" hollow concrete block back-up wall. Deterioration is due to vertical loads imposed by shortening of the structural frame. Lack of soft joints below the shelf angles to accommodate movement has resulted in;

1. Bowing of walls.
2. Crushing of over stressed units.
3. Shear failure of the header courses.
4. Rotation of shelf angles

Corrosion deterioration has also occurred in the shelf angles and connecting bolts. Due to occupation of the dwellings, complete replacement of the walls was impractical. Thus Halsall Associates in conjunction with CLS Cintec Canada participated in the development of a stabilization strategy.



The proposals were:

a. Use of the Cintec corbel anchor to transfer vertical loads from the exterior walls to the back-up walls.

b. Broken header ties to be restored using Cintec stitching anchors.

These concepts were proven with full laboratory load tests. Results available upon request.

In areas where the exterior walls were beyond repair, Cintec anchors were installed with retaining plates to prevent collapse of the panel, while it was being dismantled. The anchor was used to tie the new brickwork to the back-up wall.

The back-up wall was found, during construction, to be not fully supported on the slab edge at some locations. A special RWT, 15mm two stage anchor was designed and supplied to provide the necessary support. This special two-stage anchor had an oversized second stage sock. This was secured into the floor slab, and the second stage was inflated under the inner leaf overhang to provide support. The use of Cintec anchors thus provided stabilization and repair on this project, without disturbance or relocation of the tenants.

Conclusions of the Test Report:

The test assembly failed by crushing of the concrete block interior (back-up) wythe at the corbel anchors. The observed failure load of 10.3 Kn (2295 lb) exceeded the design (service) load of 2.85 Kn (636 lb) by a factor of 3.6.

Engineers

Halsall Associates, Toronto, Ontario, Canada

Contractors

Maxim Group General Contractors, Concord, Ontario, Canada

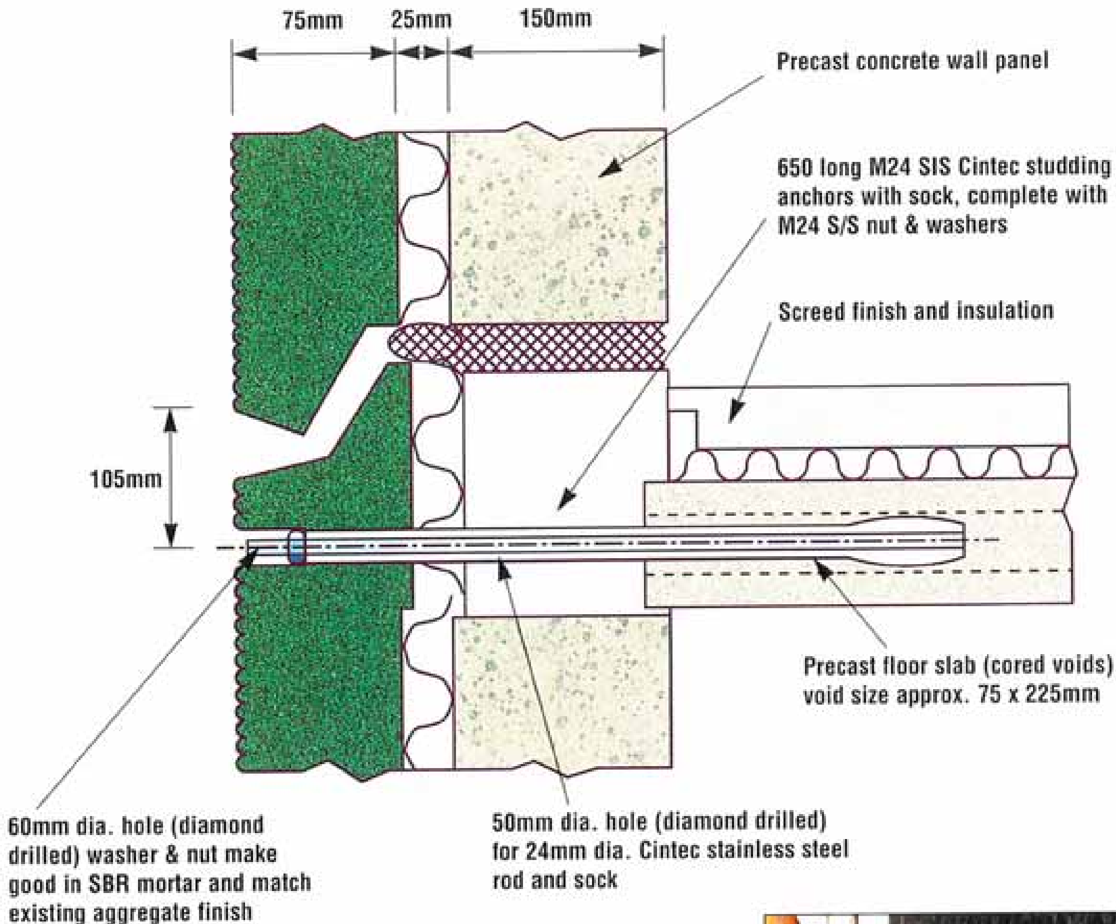
CASE HISTORY

HIGH RISE REMEDIAL WORK AT FITZWARREN COURT, SALFORD, ENGLAND, U.K.

Fitzwarren Court is a large panel construction high rise, and over its life had suffered from the ingress of water which not only caused the normal structural damage and inconveniences, but also led to the deterioration of the panel fastenings.

Engineers Wright Mottershaw had experience with this type of structure elsewhere in the UK and proposed the Cintec System as being the most appropriate to fasten the external and inner skin to the hollow floor beams.

CASE HISTORY




Drilling

The design required a working load per anchor of 40kN and 75kN ultimate in tension. In tests during installation the anchors exceed these parameters.

The anchors were designed to inflate within the void of the floor beam and were inserted through a 50mm diameter hole in the outer and inner skins and into the end of the void - a horizontal slot approximately 60 mm x 150 mm with radius ends.

The anchor body was of high tensile stainless steel studding, capable of carrying the load, surrounded by a fabric sock to contain the cementitious grout. At the outer end, an exposed stud protruded by approximately 200 mm to facilitate the termination to the outer panel via a counter bored hole and heavy gauge large washer and nut.

Concrete repair techniques were used to finish and hide the bore hole.


Anchor prior to injection

Locating the floor beam voids presented some initial problems but these were resolved by site investigation by the contractors and engineers together and the time taken up by the problem was quickly reclaimed and the project finished ahead of schedule.

This unique system was chosen because of the engineering benefits, not least of which was the total control of the grout field; but also there was no need to require the occupants of the block to leave, because all the work could be done from the outside.

The problem of Fitzwarren Court are not uncommon, Cintec has since used this remedial repair system on other structures, both High and Low Rise.

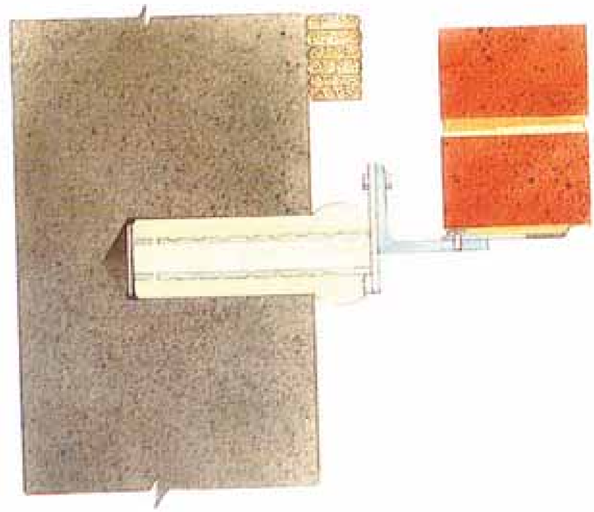

Injecting grout into anchor

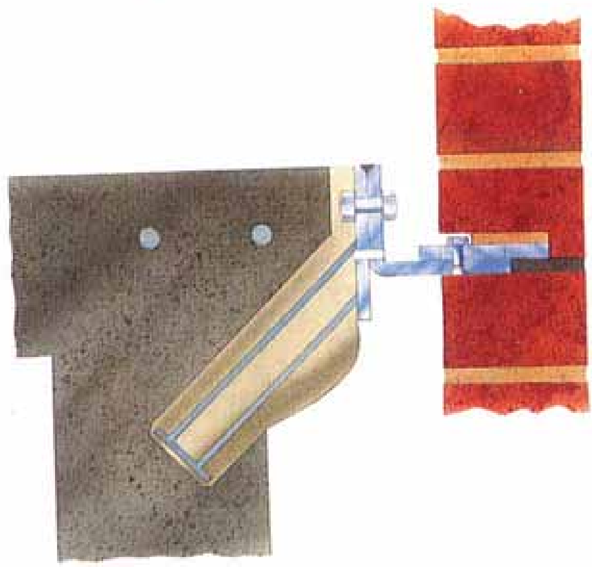
CASE HISTORY

OLIPHANT COURT, PAISLEY, STRATHCLYDE

Scottish Special Housing Association designed and supervised the renovation of this fourteen storey apartment block using the Cintec corbel anchors and wall ties during 1987/88. The block was constructed of an insitu reinforced concrete frame with concrete floors and an insitu edge beam with an overhanging nib to support the external brickwork. creep and shrinkage of the concrete frame were primarily responsible for cracking and bowing of the external brickwork.

The external brickwork required replacement, so the outer leaf was dismantled. Re-building of the outer brickwork leaf was accelerated by the provision of the stainless steel angle supports at each floor level. The simple horizontal corbel anchor into the slab could not be employed because it would have cut the top edge beam reinforcement. Instead, Cintec corbel anchors inclined at 45° were supported over the downstand beams and used to support the stainless steel angles supporting the external leaf of brickwork. The brickwork was built off the steel angles in storey heights with thermal movement joints at the underside of the angle over. Cintec RAC wall ties were used to tie the new leaf of brickwork to the internal leaf of blockwork.



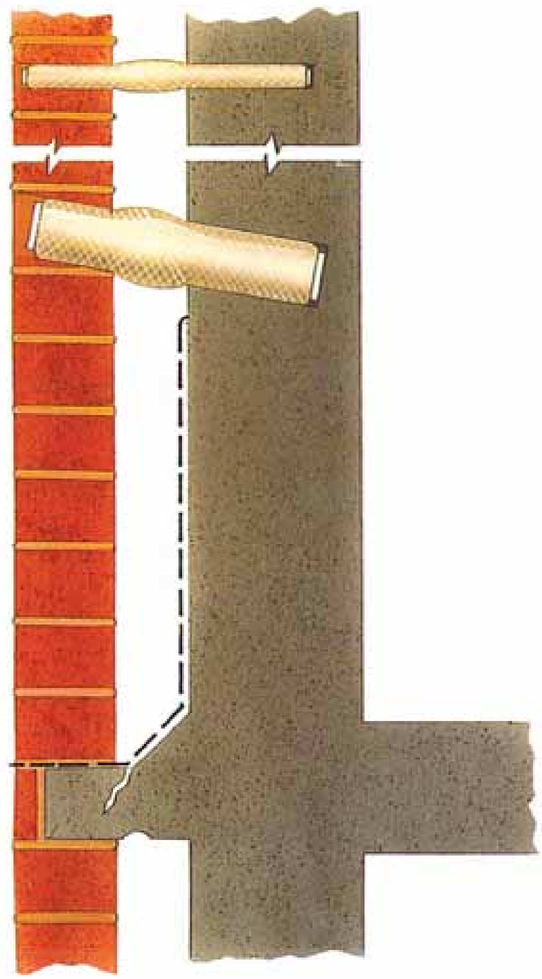


Section through floor edge beam

HIGH RISE APARTMENT BLOCKS, GLASGOW

Scottish Special Housing Association designed and supervised the renovation of 18 No. fifteen storey apartment blocks using Cintec corbel anchors and wall ties during 1984-1987. Typically the blocks were constructed of insitu reinforced concrete inner walls, columns, beams and floors with brickwork cladding on the edge of the floor slab and supported by the concrete frame. The major defect was the deterioration of the concrete nib supporting the brickwork cladding with subsequent cracking and bowing of the external brickwork. These problems were caused by creep and shrinkage of the concrete frame.

The support provided by the concrete nib was replaced by the installation of Cintec corbel anchors at approximately 700mm centres at each floor level. The anchors were embedded approximately 90mm into the inner concrete leaf. The corbel anchors were 30 x 30 x 3 SHS stainless steel sections with an external sock in a 60mm diameter core holes, which was filled with grout injected under pressure of approx. 3 bars. The external face was filled with a high-bond expanding mortar to match the existing brickwork. Cintec wall ties, 10 x 1 CHS stainless steel sections in a nominal 20mm diameter core hole, were used to restore the integrity of the brickwork panels to the required standard. Laboratory tests were undertaken on the compressive strength of the grout and the metallurgical and tensile properties of the stainless steel sections, whilst the installed anchors were checked using borescopes for deformed shape and adequacy of fixing.



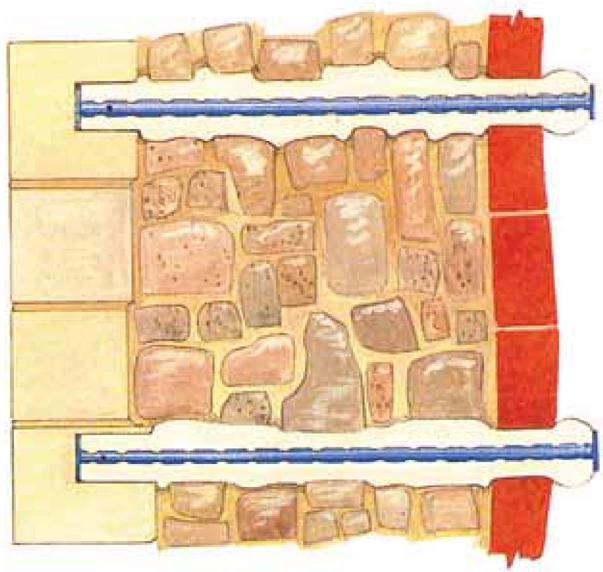
Section showing nib detail at floor level

STOWE HOUSE, BUCKINGHAMSHIRE

Sister to Buckingham Palace

Originally the country residence of Lord Buckingham, Stowe House has long been the home of a leading public school (that is a school funded by private fees). The wall construction is an external leaf of Bathstone with rubble infill and an internal masonry wall, having an overall thickness of up to 1150mm. A length of this wall was to be stabilised by grouting the rubble infill. However, the wall required strengthening to withstand the pressure of this grouting.

The solution was to install Cintec 20 x 2 CHS stainless steel anchors in a nominal 40mm diameter drill hole of centres in the range 750-900mm. Anchor lengths of 850mm and 1075mm were employed to cater for the variable wall thicknesses. To maintain the external appearance, all anchors were installed from the inside of the building. They were allowed to project into the building to permit the standard circular crimped anchor body. The anchor projection was cut off flush internally and plastered over.



Section through external wall

Contractor: Balvac whitley Moran

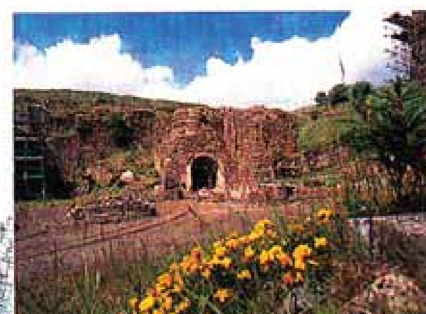
CASE HISTORY

BLAENAVON IRONWORKS SOUTH WALES (UK)

The furnaces at Blaenavon were built in 1788-89, and by 1796, were the second largest ironworks in Wales until its demise in the 1880's. It is now in urgent need of attention, CADW, responsible for the renovation of Welsh historic monuments, are involved in a programme of restoration to the main furnaces at Blaenavon.

A series of anchors have been installed to support the delicate structure to allow access for repairs and refurbishment.

A digital 3D model has been produced for the engineering team responsible for stabilisation of the structure. Working in very difficult conditions the team collected data to produce 3D elevations of all the faces of the furnace.

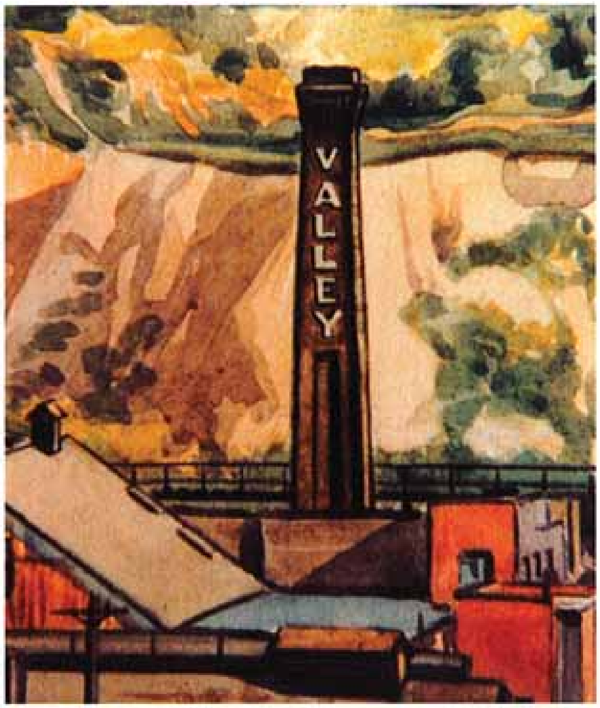


Drawing by Sir Richard Colt Hoare from Cox's Tour in Monmouthshire 1799 – Courtesy CADW

Drawing: Plowman Craven & Associates (Tel. 01582 76556
Photo: Welsh Historic Monuments, CADW

CASE HISTORY

DON VALLEY BRICKWORKS CHIMNEY RESTORATION, TORONTO, ONTARIO, CANADA



Don Valley Brickworks Contemporary Illustration

10,000 years ago in the Don Valley near Toronto, the last glacier in the area laid a deposit that formed the foundation, aeons later, for the production of clay bricks in the Don Valley Brickworks. Many of those bricks formed the basis of old buildings in Toronto. But the Brickworks fell into disuse and ruin with a sole remaining chimney marking the place of the old heritage site. McGillivray Architects were selected to restore it.

The Chimney, built in about 1890, had serviced three adjacent downdraft kilns. The shaft had been deteriorating through the years and had become a pigeon roost! Significant cracking appeared on the east and west elevations and it was found to be leaning almost 43 inches to the south and a bit to the west. The corrective action was to stitch two sides together using the Cavity Lock Systems Ltd (CLS) Cintec Anchoring System. The CLS Cintec Canada Company had had previous experience in similar projects obtaining excellent results in what is truly corrective surgery on buildings. The restoration work also included substantial repointing and some brick replacement.

Architects :
McGillivray Architects

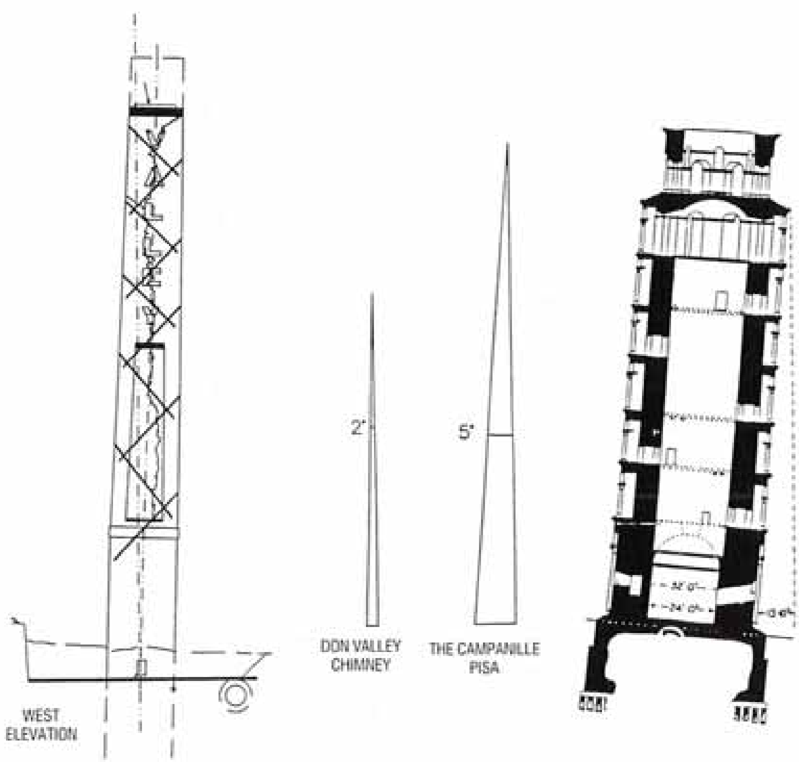
Structural Engineers :
Halsall Associates Ltd

Contractor :
Ontario Restoration Ltd

Cintec Approved Contractor :
General Concrete and Cutting Ltd

Clients :
Metro Toronto & Region Conservation Authority who said :

"Over a year ago, when we first addressed the restoration and stabilisation of the chimney, we could not have foreseen the level of effort and commitment required to complete this task. However, the success achieved over these last few months has clearly demonstrated that the product was well worth the effort."



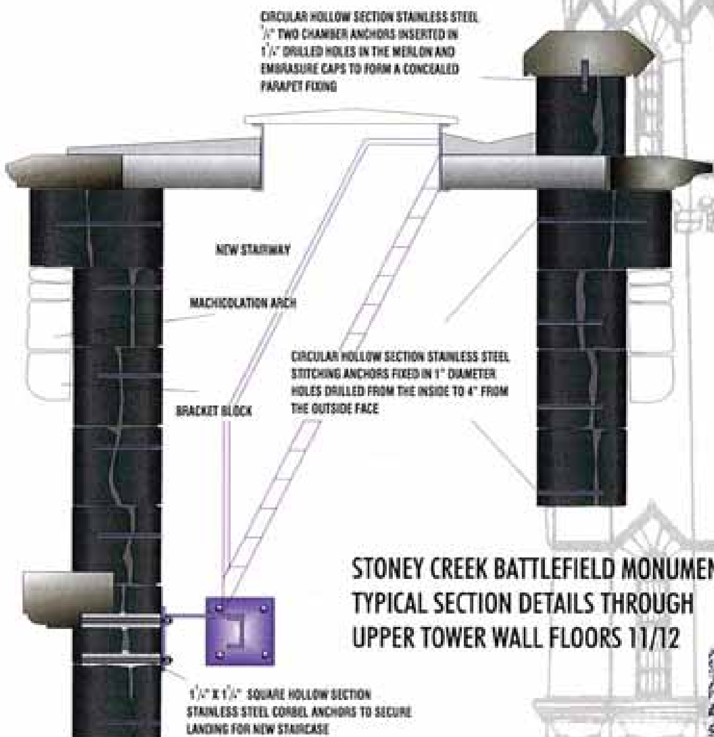
Drawing of the Don Valley Brickworks Chimney in relation to the Leaning Tower of Pisa

Chimney Restoration In Progress

CASE HISTORY

STONEY CREEK, ONTARIO, CANADA

Restoration of the 100ft (30m) Stoney Creek battlefield monument by the installation of cementitious grout anchors



STONEY CREEK BATTLEFIELD MONUMENT
TYPICAL SECTION DETAILS THROUGH
UPPER TOWER WALL FLOORS 11/12

The Stoney Creek Battlefield Monument is the centrepiece of Battlefield Park and was erected in 1913 exactly 100 years after the battle for which it is named. It was here that the British repelled an invading American force. The Restoration of the monument was executed by architect Alan Seymour. It consists of a slender stone tower, 100ft high, going from a castellated and tunnelled blockhouse sitting atop a steep slope approached by a monumental flight of steps. Unfortunately the monument was showing conspicuous signs of deterioration. The restoration included the installation of Cintec cementitious grout anchors to stitch the severely cracked inner and outer wythes of the lower walls. A total of 526 such anchors were used ranging from 12 to 31 inches long (305 to 790 mm), on a 2- x 4- foot (0.6 x 1.2 m) staggered grid. Following installation of the anchors, 54 cubic feet (1.53 cu.m) of conventional grout was injected. Cintec Canada Ltd provided the anchor system which will maintain the monument's structural and architectural integrity well into the next century. The citizens of Stoney Creek now enjoy their splendid monument in its full glory.

CASE HISTORY

FULLER'S BREWERY, LONDON U.K.

TRIAL BY FIRE

Cintec anchors were put to the test in two ways at the Fuller's Brewery in London. First anchors were used in major structural repairs to the Brewery. However, the unique qualities of those anchors were clearly demonstrated in the second test - when the Brewery was destroyed by fire.

Remedial anchors installed prior to the fire. The anchors are still functioning. The grout cover protected the main steel body of the anchor.

Even though the brickwork had been subjected to extreme temperatures, the anchors survived well; pull out tests revealed that they still performed to their original design specification.

CASE HISTORY

THE RESTORATION AND STABILISATION OF THE BLISTS HILL FURNACES, TELFORD, ENGLAND, U.K.

Introduction

The repair and restoration of the Blists Hill Furnaces, which form part of the Blists Hill Open Air Museum Site near Ironbridge, Telford, has recently been completed. The works were instigated as part of a major repairs programme designed to renovate and restore, numerous structures within the Ironbridge Gorge heritage Site.

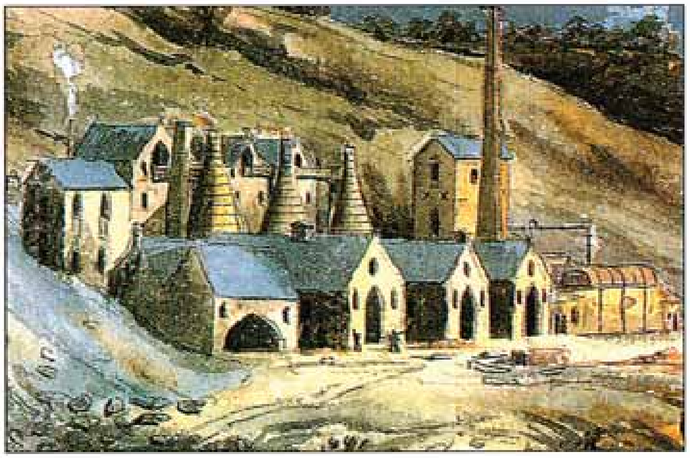
A detailed repair schedule was prepared for each of the sites by a working party, including architects, civil and structural engineers, surveyors and archaeologists and the work funded by the Department of the Environment.

The purpose of the repair work was to restore and renovate the properties and structures to an acceptable condition whereby the ownership and future maintenance of the structures would pass into the care of Ironbridge (Telford) Heritage Foundation.

In order to bring about the restoration and stabilisation of the Blasts Hill Furnaces, it was necessary to undertake remedial work on the existing brickwork and stonework, together with the introduction of extensive ground anchors and tie bars.

Work required to prevent further ingress of surface ground water into the furnaces was undertaken as a separate, but integral, phase of the works.

CASE HISTORY



Background history

The Madeley Wood Company was formed in 1756 when the ironworks at Bedlam, one mile west of Blists Hill, on the River Severn, was founded. The Bedlam Furnaces were owned by this company, which held mineral leases in Madeley Parish, enabling it to extract coal and iron ore. Upon its opening in 1790, the Company had access to the Shropshire Canal, the Blists Hill section of which ran immediately to the east of the Blists Hill works site. Proximity of raw materials and the means of transporting the finished product persuaded the Company to build a blast furnace at Blists Hill in 1832.

Additional furnaces were added in 1840 and 1844, making a total of three and the site remained active in the production of pig iron until 1912, when the ironworks ceased production, following the blowing in of two of the furnaces.

The site history through the 20th century is less well documented. Dense vegetation was allowed to establish itself amongst the ruins until the late 1950s when the site was subject to spoil dumping which completely buried the furnace bases. In the 1970s the Ironbridge Gorge Museum Trust began clearing and restoring the works.

Structural defects

The buildings had fallen into poor repair due to the ravages of time and the ingress of ground water. This dereliction and general instability of the furnace structures represented a hazard to the preparation of a specification for the repair. It was, therefore, necessary to undertake the design and installation of an extensive scaffold propping scheme to enable the facade of the structure to be stabilised sufficiently to enable the appraisal and detailing of repair work.

The scale of works was restricted due to the nature, historical and archaeological importance of the site. Problems were encountered during the design stage of the scheme due to the presence of many underground tunnels and chambers which linked the surface bases back to the main engine houses.

By buttressing the supporting scaffolding back onto the old furnace bases and utilising heavy concrete blocks as kentledge, sufficient dead weight was applied to stabilise the temporary propping. Prior strengthening of the furnace bases was required to ensure that the high loads from the buttresses could be transferred to the sub-strata without distressing the superstructure.

Drilling

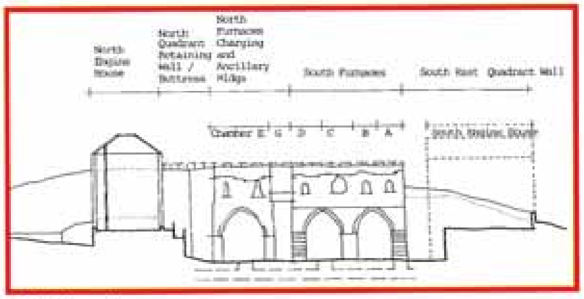
Restoration work in progress

CASE HISTORY

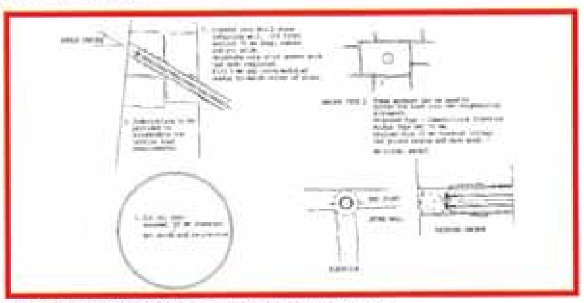
RESTORATION & STABILISATION OF THE BLISTS HILL FURNACES, TELFORD, ENGLAND, U.K.

Following completion of the propping scheme a detailed visual and photographic inspection of the site structures was undertaken to ascertain and record the condition of the walls and to determine the cause of the damage, enabling the formulation of a repair and stabilisation strategy. This appraisal concluded that the damage which had occurred could be generally summarised as follows:

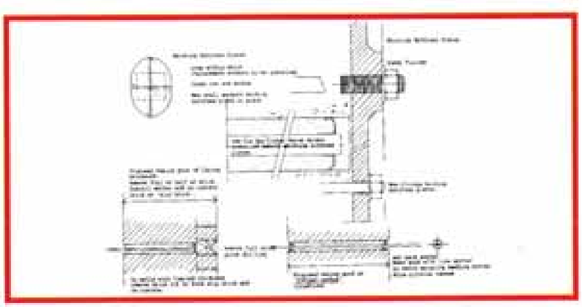
- Superficial damage of the masonry and stone walls cause by the presence of vegetation and water ingress. This was most evident at the top of the structure, where significant loosening of the brick and stonework had occurred with subsequent loss of the retained material. Water penetration, in conjunction with frost action, was also causing significant deterioration to the fabric of the brickwork and stonework.
- Differential settlement in the south wall of the furnace charging building resulting in westward rotation of part of the wall and consequent vertical and diagonal cracking through the superstructure supported by it.
- Cracking and spreading movements in the superstructure, resulting in outward displacement of walls.
- Distress cracking, loss of material and localised collapse of the stone masonry retaining walls which were up to 13m high.



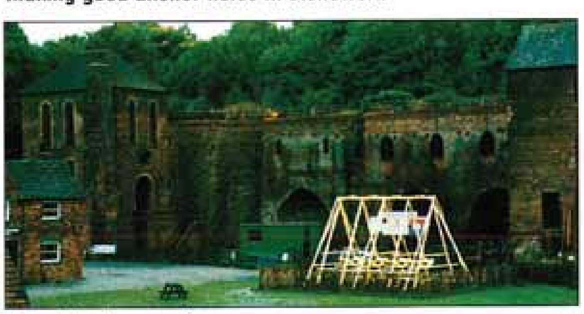
Side Elevation



Making good anchor holes in stonework



Making good anchor holes in stonework



Completed renovation

The geology of the retained ground was investigated, using shell and auger holes, with subsequent laboratory tests to determine the characteristics of the subsoils. The investigation concluded that the site is overlain with topsoil on fill materials form 6 - 11 m deep. The fill is principally ash containing one or more of brick and tile discards, blast furnace slag and coal. It is deposited on mudstones containing strata or lenses of sandstone and hard clay. The mudstone at the fill interface is frequently softened to a medium clay due to weathering caused by the presence of ground water.

Rates of deformation and crack development

Since the excavation of the structure in 1980, a number of structural movements appear to have taken place, as evidenced by cracking and distortion of early repairs undertaken by the Ironbridge Gorge Museum Trust. No long term records exist, but during the preparation of reports for the repairs brief, it was visibly noticeable that movement and cracking was worsening, confirming that it was progressive. In addition to this cracking, rusting of the cast and wrought iron plates, lintels and tie bars within the structure was continuing, due to the ingress of ground water, with a consequent splitting and heaving of masonry. This in turn caused increased water penetration to the structure.

Remedial measures

Following detailed discussions with English Heritage, a series of remedial measures to stabilise the structures was proposed. This work included the general consolidation of voided and eroded brickwork and stonework in conjunction with the installation of new tie bars and ground anchors. The selection of the ground anchor and tie bar was the subject of careful consideration, due to the very significant archeological and historical importance of the structure.

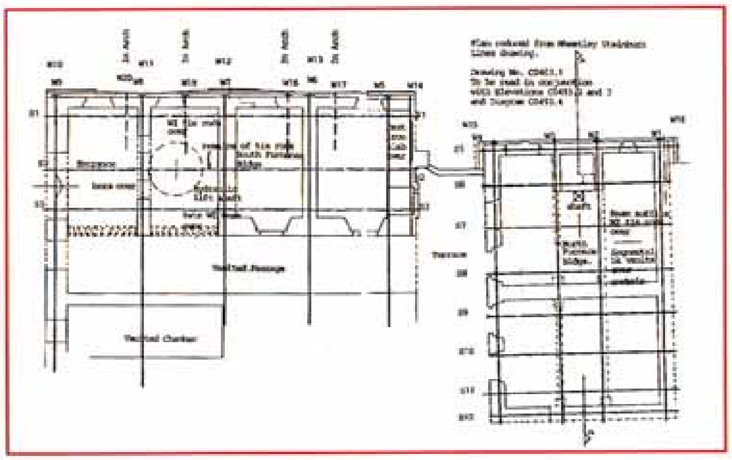
CASE HISTORY

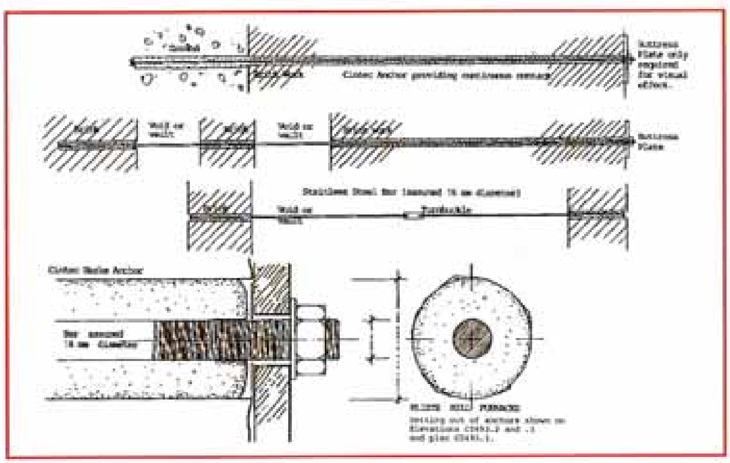
Concern was expressed that any grout used in the anchoring works should not be allowed to penetrate areas of the structure in an uncontrolled fashion.

The Cintec Anchors provided not only the correct structural solution to the problems but also enabled the work to be undertaken in a controlled manner, with the grout restricted to only those areas around the anchors where it was structurally required. The Cintec Anchors were used to replace the eroded and rusted tie bars, in addition to their use for the ground anchorage work on the project.

Careful consideration and planning was undertaken by the design team in conjunction with the specialist sub-contractor so that all the anchors and ties were installed with minimal visual disturbance to the building structure, not only during installation but also upon completion of the work. The ground anchors were required to sustain a maximum safe working load of 60kN and this was achieved by socketing the Cintec Anchors a minimum of 3.0 m into the mudstone strata.

The ground anchor installation required a 100 mm diameter core to be taken out of the centre of a selected stone within the retaining wall. Drilling was then undertaken with or without a steel casing, using an air flush drilling system, to a designed anchor position and length of embedment into the underlying mudstone. Even with this angular adjustment the length of the Cintec Anchors was in excess of 20m. The Cintec Anchor was then inserted in the hole with the sock positioned around the anchor. The whole anchor was then pressure grouted to within 100 mm of the face of the wall. Finally the original core was refitted into the core hole and resined into position so as to mask the end of the anchor.





Where necessary, due to the location of th anchor within the wall and the adjacent stones, the insertion of small diameter stainless steel needles was undertaken. This 'stitched' the area around the anchor together. Generally a Cintec RAC 10 mm diameter anchor was employed with the anchors positioned into the bed joints of t stone retaining wall. In most cases 5 Cint RAC anchors were installed around each ground anchor position.

Within the south and north furnaces wher vault tie bars were to be replaced, the use the Cintec Anchors was once again adopted. The new ties were inserted adjacent to the locations of the existing patress plates initially removed to enable drilling to take place. The anchors were installed in 50 mm diameter holes cored through the brickwork and where necessa into the mudstone strata behind the structure. The anchors and socks were inserted and grouted within the brickwork/mudstone, leaving the exposed areas of tie bar clear of any grout. The existing patress plates were re-fixed in the existing position so as to mask the repair works and leave the structural appearance of the building apparently unaltered.

Conclusions

The use of the Cintec sleeved anchors has enabled the stabilisation and renovation of this very important archeological and historical structure to be achieved. The anchors were able to satisfy the necessary structural criteria whilst enabling all the operations to be fully controlled, thus producing only a nominal visual and archeological impact on the structure which remained apparently unaltered.

HOUSES AND APARTMENTS, BASILDON

The Commission of New Town wished to enhance the robustness of 400 No. houses and 200 No. 3-4 storey apartments, particularly against the effects of accidental damage. The Cintec anchor was adopted primarily on the basis of cost-effectiveness and least disturbance to the tenants.

Enhanced robustness was achieved by the installation of stitching anchors 6m long tying the front and rear elevations. It required the development of dry drilling techniques and carefully co-ordinated management so that tenants were only required to absent from their properties for one day between 8.00am and 6.00pm. The anchors passed through concrete hollow floors with careful control of level. Special socks and grout pressures were designed for the particular application. Particular attention was paid to keeping tenants informed and to meeting their individual requirements. As a result all the work was completed within cost and programme to the satisfaction of the clients and tenants.

Section through hollow floor

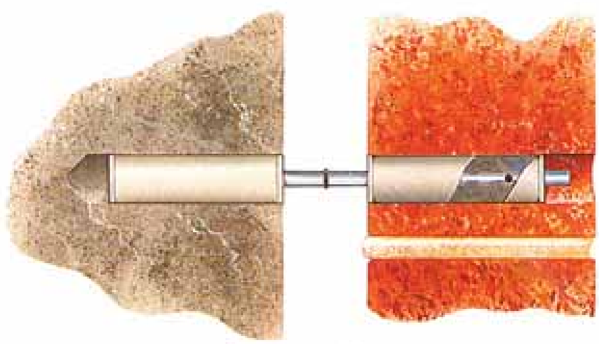
WALL TIE REPLACEMENT, CARDIFF

Black ash mortar was used in the construction of many houses in Cardiff and other regions in the United Kingdom. Ingress of moisture through the external brickwork leaf and mortar causes the formation of acidic agents which cause corrosion of the wall ties. Particularly at risk from corrosion are the zinc-coated wall ties which have been traditionally employed in UK housing.

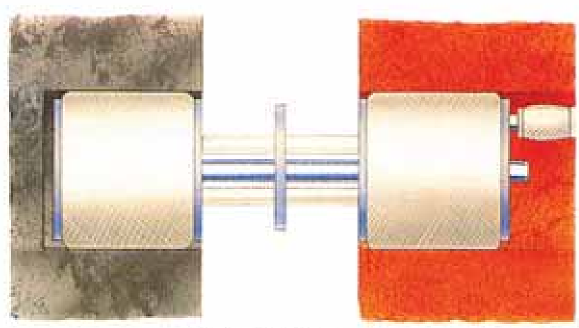
The Cintec RAD replacement wall tie was specifically developed to overcome the problems associated with black ash mortar and tie corrosion. Removal of the existing wall ties is the preferred solution because if the wall ties are bent-back further corrosion can lead to damage to the finishes on the internal skin of brickwork, due to the expansive forces caused by the corrosion.

The existing ties were located using a metal detector. They were over-drilled using a 60mm diameter over-coring drill and removed. The 60mm diameter Cintec RAD anchor was installed based on 10 x 1mm CHS stainless steel section with socks at either end in the external and internal walls. Grout was injected under pressure and the external skin was made good to match the existing brickwork.

The photograph of a typical house in Butetown, Cardiff is typical of the use of Cintec RAD anchors. In Cardiff, over 500,000 RAD anchors have been installed in the housing stock, thus securing the continued life of the housing and removing the problems associated with corrosion of zinc-coated galvanised steel wall ties.



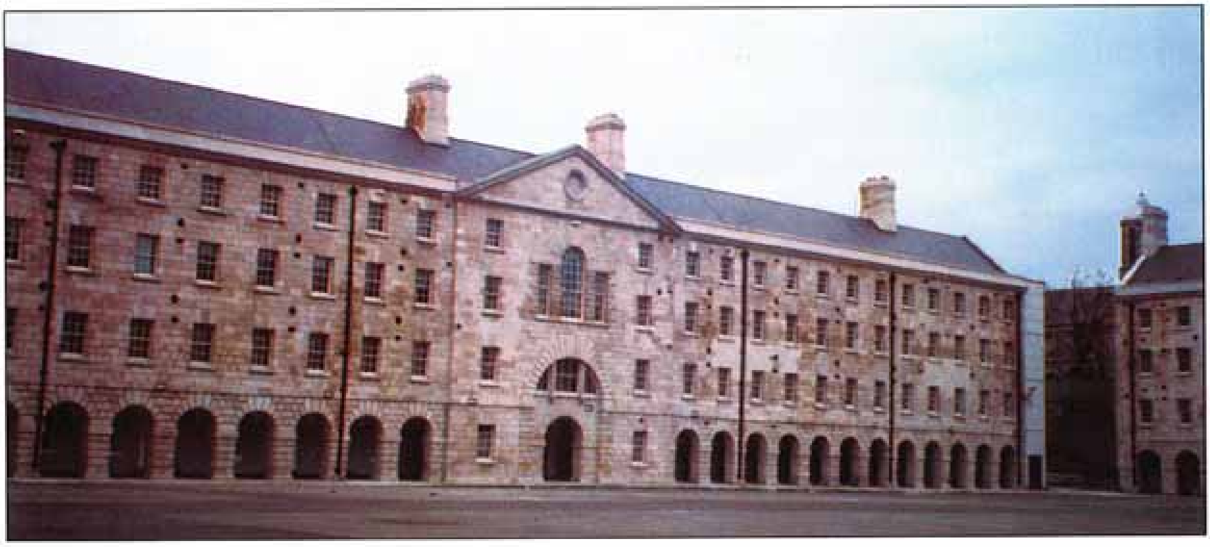
Supplementary wall tie



Replacement wall tie

CASE HISTORY

COLLINS' BARRACKS, DUBLIN, REPUBLIC IRELAND



Dublin's Collins' Barracks is an 18th century building of significant historical interest.

A photogrammetric survey of the walls of the 18th century army barracks indicated that significant movement had taken place in the stonework over time. A number of the main walls and archways required stabilising, and the ashlar granite face of the walls needed tying back to the core and inner skin.

Internal alterations at the barracks involved the installation of steel framing to support and stabilise the remaining walls. Cintec anchors were chosen to tie the granite facing back to the body of the wall and to tie the walls to the steel framework; approximately 250 700 x 2500 stainless steel anchors were used to stabilise the steel cage.

Steel framing

Anchor granite face

Over time, archways in both East and West blocks of the barracks had moved outwards form the intervening floors or vaults.

Cintec anchors provided the practical, engineered solution to such problems. Anchors measuring 3.6 metres were installed in the West block, to tie the walls of the archway to the backing wall of the cloister, through the brick vaulting.

Two outer walls of arches in the East block were tied together using anchors installed in the 1100mm thick walls and linked through the building with tie bars and turnbuckles. Here the anchors were enlarged to form pattresses within the wall, and the core holes were plugged to match the granite, leaving no visible signs of repair from the outside.

CASE HISTORY

COLLINS' BARRACKS, DUBLIN, REPUBLIC IRELAND

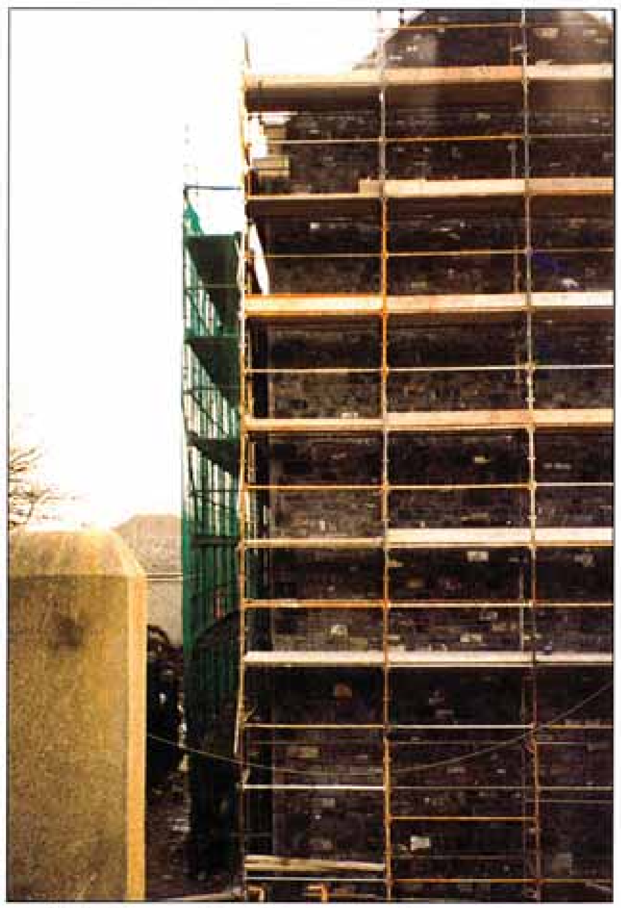
Anchor insertion approx 680 - 650mm x 10mm stainless steel anchors for facade retention

East block front and back arch tied with anchor assembly running from front arch to rear through floor

Alterations about the turn of the century included the construction of a gable wall on the North block, which had later separated from the main wall - Cintec anchors were used to stitch the two walls together.

The successful use of the Cintec anchors ensured a sound anchorage, without the loss of grout, as the sock followed the shape of voids in the rubble.

West block during restoration



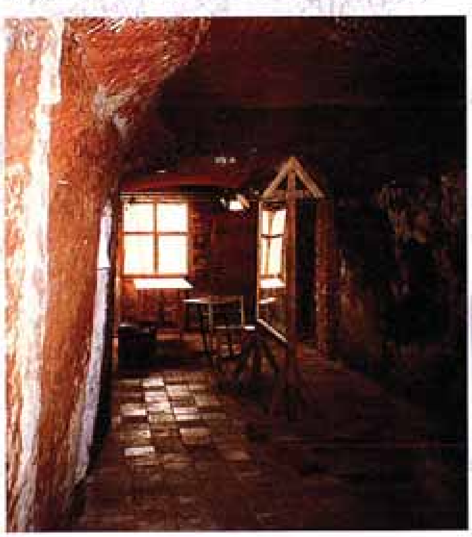
4 - 1800 x 30mm and 4 - 2200 x 30mm stainless steel anchors were used to stitch crack vertically up a five storey gable wall

CASE HISTORY

HOLY AUSTIN ROCK – KINVER, STAFFS, ENGLAND, UK

Illustration – Courtesy of John Greaves Smith

External view of main entrance to restored dwelling.



Internal view of front room, above cave.

RESTORATION OF THE LOWER CAVE DWELLINGS AT HOLY AUSTIN ROCK, KINVER EDGE

The Name 'Holy Austin" is said to be after a hermit who lived near the site during the 16th century. This is the earliest known reference to the occupation at Holy Austin rock.

In May 1993 the National Trust completed the first phase of restoration in their imaginative scheme to restore the nationally important cave dwellings at Kinver Edge, Staffordshire. Since the rock houses were cleared of their last occupants, as late as the 1950's, the rock structures had deteriorated and several of the caves within the three-level complex of up to a dozen separate dwellings had become dangerous. In 1990, the Trust took a bold decision to re-build the upper rock houses and to bring the interior up to modern standards for a Custodian to control the area immediately around Holy Austin Rock.

The Lower Caves were still a serious structural concern. They had been crudely bricked up by the local Council in the 1950's for public safety, as there had been extensive rock falls from the ceiling of the large central cave – an amazing tunnel known in latter years as the Ballroom.

With the financial support of the local Management Committee, the National Trust once again commissioned the Architect for work to secure the Lower Caves, and also to restore the facades and one or two of the rooms to their original design.

The unstable condition of the soft red permian sandstone required careful and often dangerous work inside the caves by the Contractor, G T Wall and Sons of Stourbridge, to secure the falling ceiling slabs.

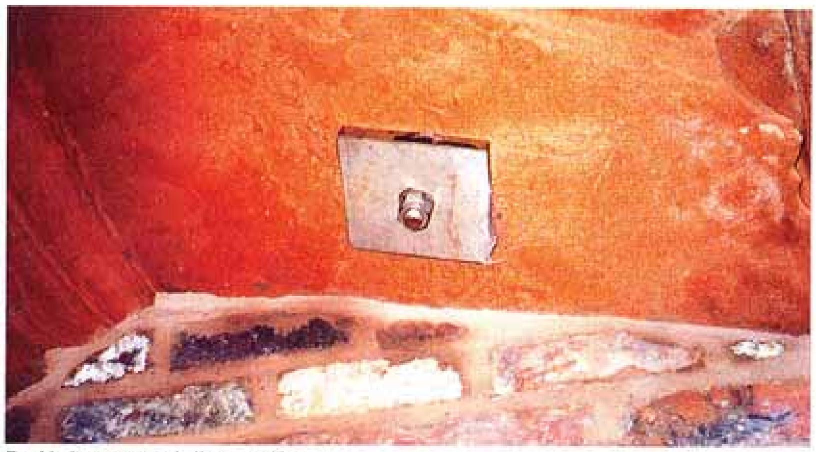
HOLY AUSTIN ROCK – KINVER, STAFFS, ENGLAND, UK

A major structural defect, resulting from the internal failures, was the large vertical fissure and associated cracks, just behind the eastern facade, which had widened in recent years due to weathering and root penetration. The Structural Engineers, Ascough and Associates, saw the danger of the whole facade falling outwards, as a 1m thick slab. It was decided to use modern rock bolting techniques to anchor this slab back to the stabilised rock including the new foam concrete fill, just above cave ceiling level. The drilling and grouting of the rock anchors was carried out by A.P.B. Group Limited of Stoke-on-Trent in August 1997. The specification was for 5 Cintec rock anchors 3 – 4m long, and 20mm diameter, 316 grade stainless steel rebars. The anchors were grouted into 40mm – 50mm diameter holes drilled with air flush rotary rock drills. In addition to the main rock bolts, several more ceiling bolts were installed under the Engineer's direction using 16mm diameter anchors of varying lengths.

The Lower Caves were completed in November 1997 and the National Trust have now raised the status of the Caves giving them a detailed entry in the National Trust Handbook.

Text – **John Greaves Smith** *Dip.Arch. R.I.B.A Architect*

Adjacent caves in unrestored condition.



Roof bolt support to ballroom ceiling.

The completed row of cave dwellings ready for occupancy.

CASE HISTORY

THE BRUNSWICK TOWER, WINDSOR CASTLE – ENGLAND, U.K.

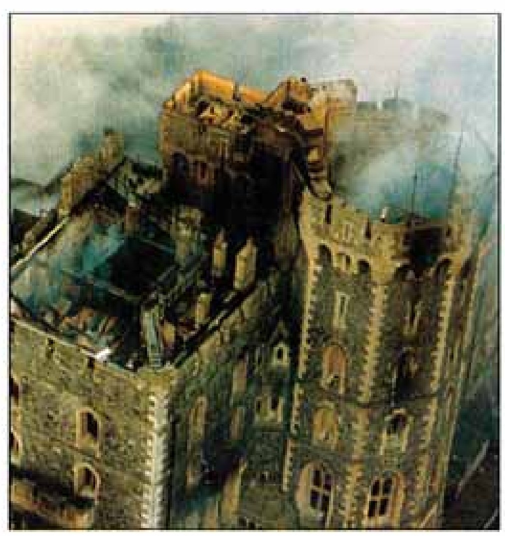
▲ Photographer: David Giles/'PA' News ▲

Windsor Castle has been a Royal residence for over 900 years and is an official residence of Her Majesty the Queen.

At 11.37 am Friday November the 20th 1992, fire broke out, and much of the Castle was devastated by the raging inferno that ensued.

The fire raged all day and at 6.30 pm the Brunswick Tower was engulfed. The intense heat caused the castellated section of the Tower to fracture, with the possible risk of collapse.

Initially there seemed little choice but to dismantle and rebuild the top section of the Tower. However the versatility of the Cintec Anchoring System enabled the engineers to design a repair solution that restored the structural integrity without further disruption to the unstable stonework.



▲ Photographer: 'PA' News

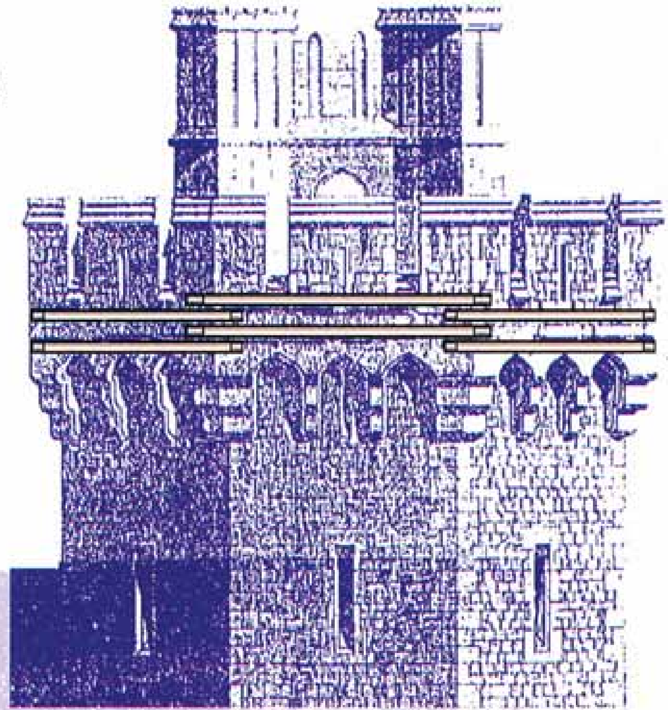
Throughout the damaged areas of the Castle Cintec Anchors were used to restore the integrity of the walls and provide repair and strengthening solutions to this magnificent Heritage Building.

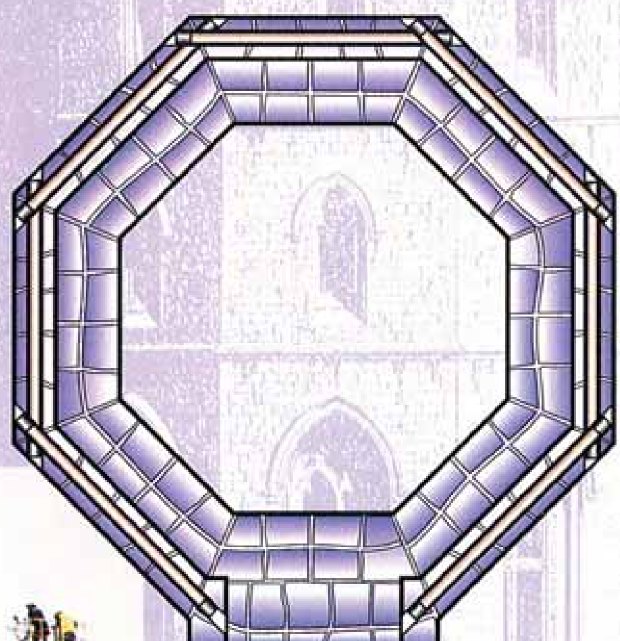
CASE HISTORY

WINDSOR CASTLE – THE BRUNSWICK TOWER REPAIR

The latest Diamond Drilling Techniques were used to create a network of holes within the stonework.

The Cintec Anchors were then installed creating a reinforcing ring, within the fabric of the stonework, maintaining the original appearance of the tower.





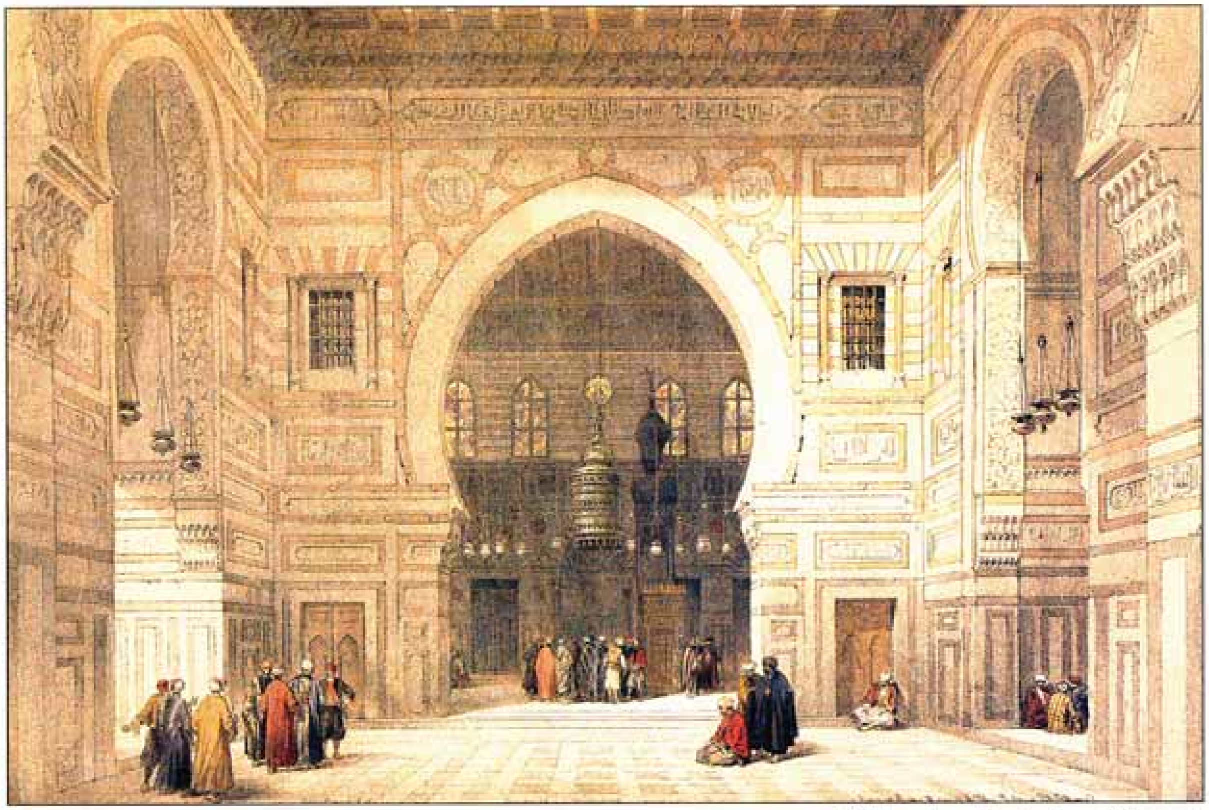
The illustration shows the arrangement of anchors used in the restoration of the Brunswick Tower.

38 Auriga Drive,
Nepean, ON Canada
Tel: 613-225-3381
Fax: 613-224-9042

307 West Pennsylvania Ave.
Towson, Maryland
Tel: 1-800-363-6066
Fax: 1-800-461-1862

E-mail cintec@ca.icomos.org
url. http:www.buildingweb.com/cintec

THE MADRASA & KANQAH OF SULTAN AL GHURI, CAIRO, EGYPT



19th century illustration of Mosque

The Madrasa and Kanqah of Sultan al-Ghouri is monument number 189 of the Mohammedan monuments under the care of the Egyptian Antiquities Organisation. It is of the date 909-10 AH 1503-4 AD.

The Sultan Qansul al-Ghouri was the last but one of the Mamaluk Sultans enjoying an unusually long reign for this period (1501-16). The Sultan died in the midst of battle against the Ottoman Turks, his body never discovered.

The funerary complex of Sultan al-Ghouri is situated in the Fahhamin quarter of Old Cairo in al-Muizz Street. On the west side there is a kanqah and mausoleum as well as a sabil kuttab. The minaret is a four storied rectangular structure approximately 50 metres high.

The Madrasa Mosque with its strong features, bold design, marble panels and intricate geometric design carved into the surface of the arches and ceiling represents the last great flowering of Mamaluk art.

The al-Ghuri Mosque

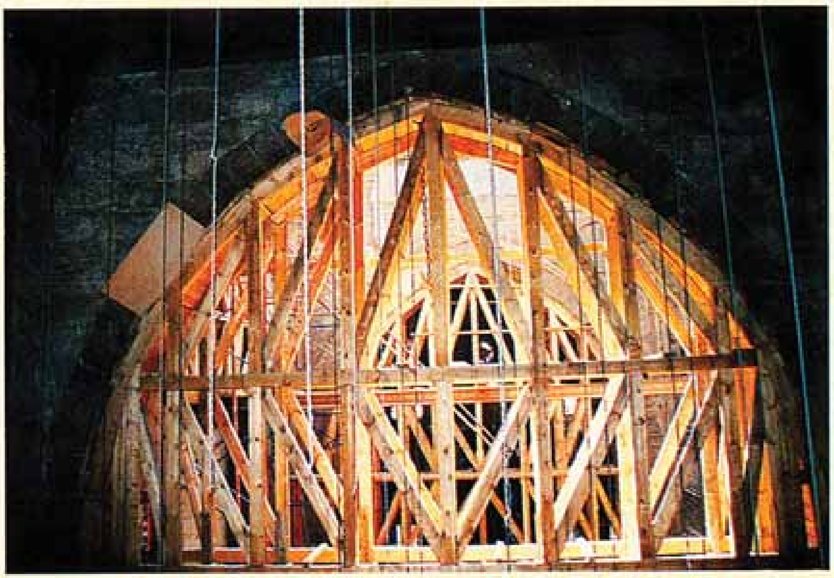
THE MADRASA & KANQAH OF SULTAN AL GHURI – THE DAMAGE

An inspection of the Madrasa revealed some very severe long-standing problems. The floor of the mosque undulated dramatically, providing evidence of very significant foundation problems of the masonry vaults supporting the floor. Attempts had been made in the past to underpin the sleeper walls supporting the vaults, these had failed. All of the walls of the mosque exhibited very severe fractures. The problems were brought about by earthquake damage in October 1992 and by the rising contaminated ground water. Further problems in the external walls had been caused by the activities of the shopkeepers trying to enlarge the space available for selling their wares. As a consequence, sections of masonry have been demolished at ground floor level to create this additional space.

Seismic damage to decorative arches

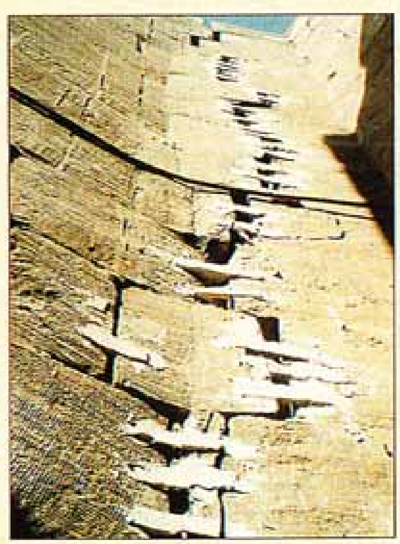
The net result of the above was that the mosque of al-Ghouri was in a very delicate state of equilibrium. Despite having survived for nearly 500 years, the toll of a rising water table, earthquakes and neglect had brought this structure to the point of collapse. Urgent measures were required to reintroduce some structural strength and stiffness into the building.

It was understood that the Madrasa was underpinned by using a system of micropiling. The requirement therefore remained to tie the elements of the superstructure together. The very high walls were laterally unrestrained and very vulnerable to lateral forces such as may be produced by the next earthquake.



Temporary support of the Dikka arches

Lintel stones

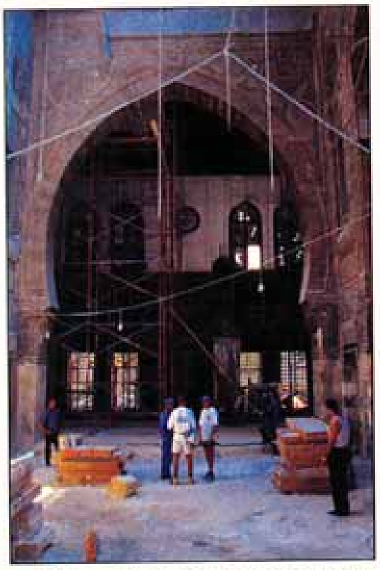


Vertical shear crack

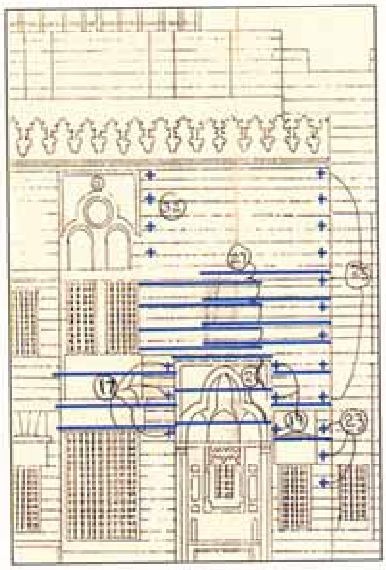
CASE HISTORY

THE MADRASA & KANQAH OF SULTAN AL GHURI, CAIRO, EGYPT – THE REPAIR

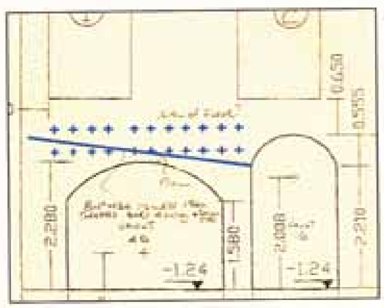
The Cintec stitching system was extensively used at al-Ghouri. These reinforcement anchors, up to 12 metres long, serve to stiffen each individual wall immensely. The walls of al-Ghouri are generally of two facing skins in-filled with a core of rubble. The large arched openings in the mosque are particular points of weakness in the structure. Longitudinal ties in each of the stone facings of the wall above the arch would serve to resist the thrusts naturally produced by the arch as well as serving to assist the walls to resist the next earthquake. In addition to longitudinal ties, transverse ties of length equal to the thickness of the wall were introduced to increase the strength of the wall.



Dikka arch in the main courtyard

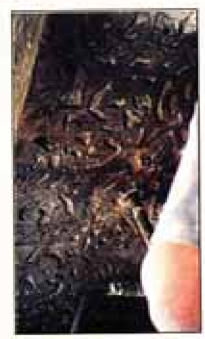


Drilling the vaults



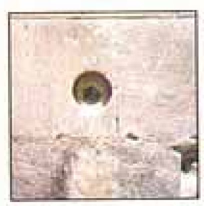
Typical repair detail for the arched vaults at ground level

Front core replaced, after anchor installation and made good

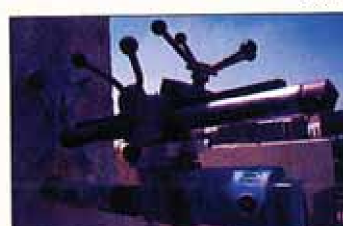


Drilling the stonework after removal of front core

Decorative panels being drilled ready for installation of consolidation anchors

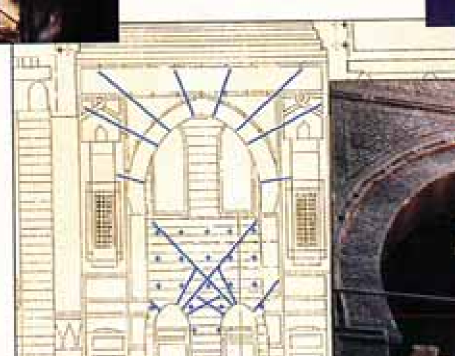


Anchor installed & inflated ready for front core to be replaced

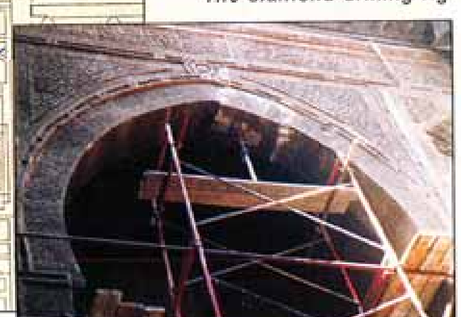


The diamond drilling rig

Diamond drilling the arch stones



Typical anchor placement details for the arches and sidela walls



One of the four arches of the court being scaffolded prior to drilling and anchoring

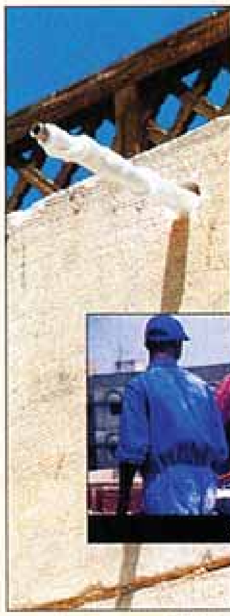
CASE HISTORY

THE MADRASA & KANQAH OF SULTAN AL GHURI, CAIRO, EGYPT

The Cintec stitches would also be used to tie the roof structure to the perimeter walls and create a diaphragm action. Again this is an internationally recognised system of introducing greater stiffness and earthquake resistance into a structure. The beauty of the Cintec anchor is that it contains the grout to be used within a sleeve and control of grout flow and its impact upon the existing structure is therefore very good.

The anchors to be used would be invisible in the repaired structure, eventually over 1200 metres of anchors were installed at al-Ghouri. The installation team needed to keep a fine balance between the archeological project and Egyptian Authority whilst encountering natural hazards like dust, confined working spaces, insects and high temperatures.

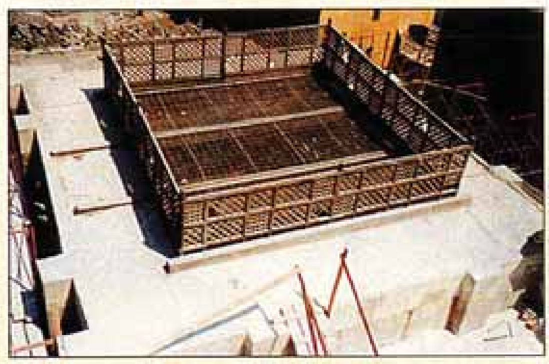
The success in refurbishing this ancient mosque, was as a result of the combined association of Cintec, Arab Contractors, Intro Trading and the advice and co-operation of the Egyptian Antiquities Organisations thus ensuring the stability of this 500 year old important heritage building.



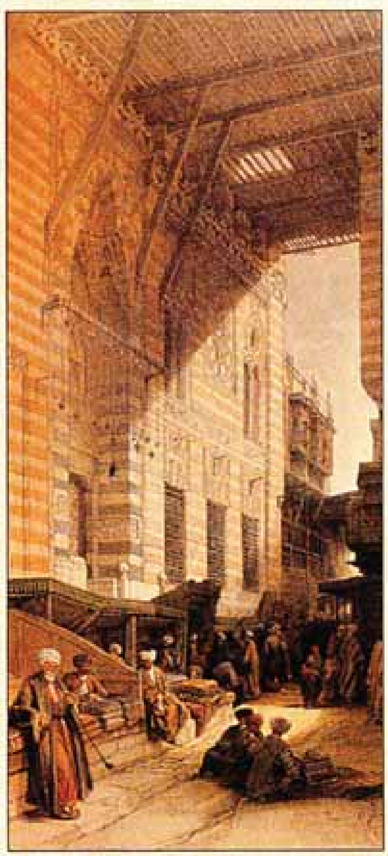

anchor insertion

typical consolidation anchor prior to grout injection

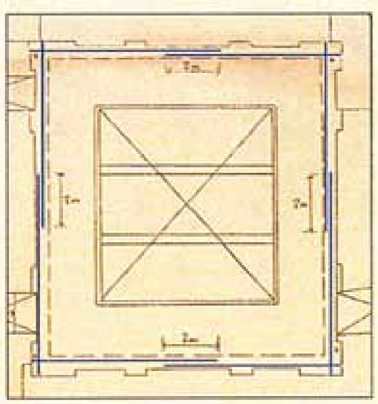
5 metre long vertical anchors at roof level



Roof section above central courtyard



Market place outside Mosque 19th century illustration

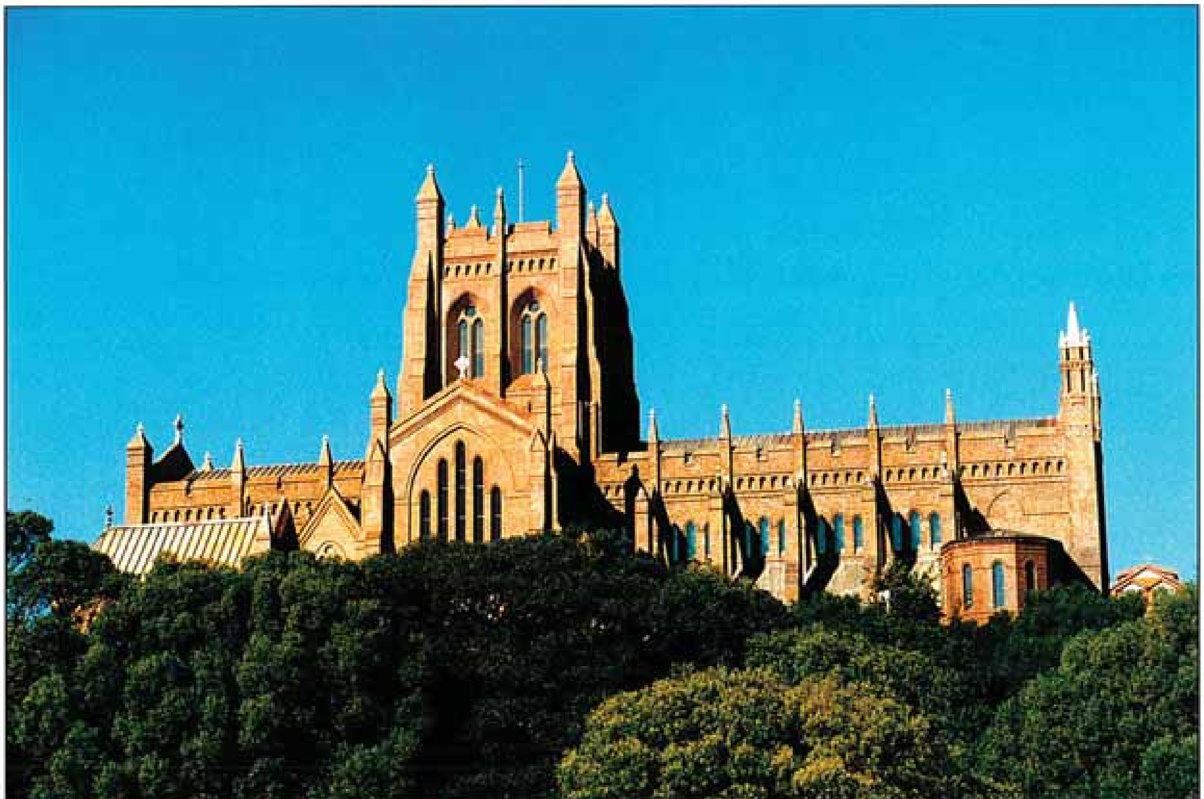


Roof consolidation anchors

installed roof anchor

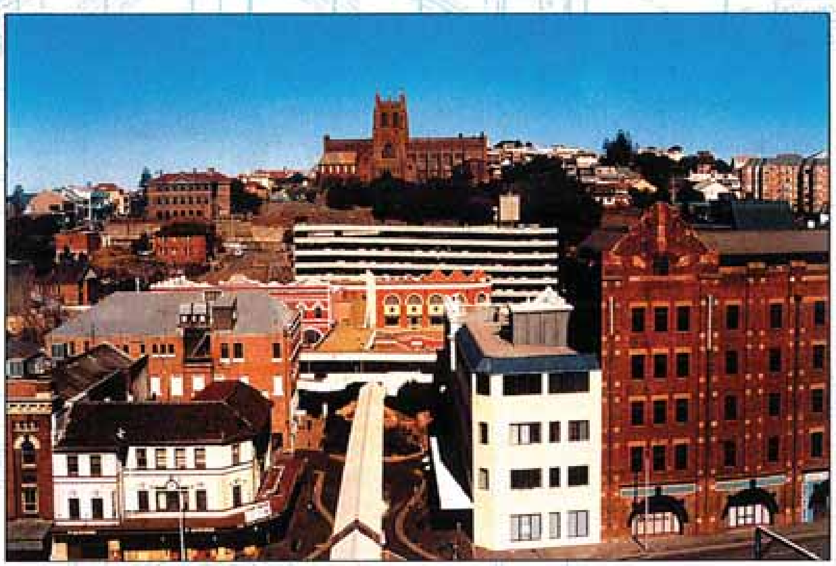
CASE HISTORY

CHRISTCHURCH CATHEDRAL NEWCASTLE, NEW SOUTH WALES, AUSTRALIA



Christ Church Cathedral is an extraordinary piece of architecture in a dramatic setting. Australia's largest provincial cathedral, dating back to 1893. Stylistically the building expresses the significant changes from the Victorian period of architecture with its reliance on academic correctness to the freer realisations of the Federation period and its influence by the Arts and Crafts movement in Australian architecture.

At 10.27 am, on Thursday 28th December 1989, the city of Newcastle in New South Wales was struck by the first significant earthquake to affect an Australian urban area. The earthquake, registering 5.6 on the Richter scale and with a Modified Mercalli Index of up to VIII, had an epicentre approximately 14 km south west of the city's centre. The most important building to be severely damaged was Christ Church Cathedral.



Christ Church Cathedral Dominates Newcastle skyline.

CASE HISTORY

CHRISTCHURCH CATHEDRAL – THE DAMAGE

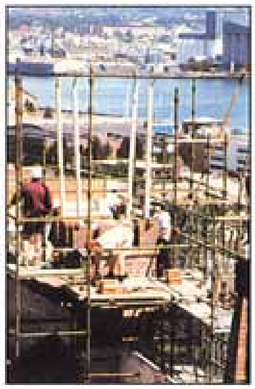
Earthquakes had previously occurred in Australia only in sparsely populated areas, and most practising structural engineers and building authorities knew little, if anything, about earthquake design requirements.

The effect of the earthquake was largely as might be expected: high set stone crosses and other decorations fell to the ground, flying buttresses were dislodged, shear cracking occurred in the north and south walls and out-of-plane movements occurred in the east wall, dislodging windows.

Work on a building such as Christ Church Cathedral is governed by State heritage legislation which invokes the International Council on Monuments & Sites (ICOMOS) principles derived from the world body's Venice Charter. To repair and strengthen the Cathedral, reinforcement of the walls was necessary, with least visual intrusion or damage to the existing fabric. Materials had to be found which were compatible with the masonry of the building and which ensured the long life for which cathedrals are noted.

CASE HISTORY

CHRISTCHURCH CATHEDRAL NEWCASTLE, NEW SOUTH WALES, AUSTRALIA – THE REPAIR



20 m vertical anchor being placed by crane in the project which saw anchors up to 32 m horizontally, Cintec's longest to date.

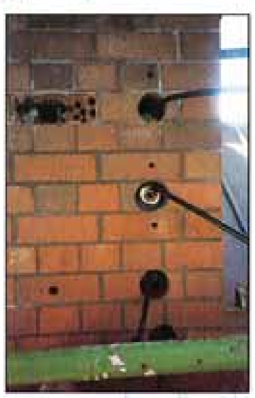
The Cintec Anchor System was chosen by the engineers to solve the Cathedral's problems when it became obvious that no other company had the materials, experience and expertise to meet all the requirements. Bill Jordan, a structural engineer who runs the Cintec operation in Australia, convinced the consulting engineers and architects that Cintec was the best solution with the lowest risk. Only Cintec was able to offer a high strength stainless steel anchor body coupled with a purely cementitious grout which was controlled by a woven sock to prevent its escape. Trial installations and tests were undertaken before Cintec's accredited installer, Australasian Concrete Services Pty Ltd was contracted to place over 4 km of Cintec anchors.

The aim of the repair and reinforcement work was to turn the building from a brittle to a ductile structure, able to resist future earthquakes. Cintec anchors were used to reinforce walls and piers, horizontally and vertically. Some steel frames were used where they could not be seen, behind parapets and in the tower.

Cintec anchors used on the project ranged from 215 mm long RAC cavity ties to 32 metre long anchors in the nave walls which were manufactured from 32 mm diameter "Hi-proof" grade 316 deformed stainless steel bar. All the long anchors had to be manufactured on site, with long vertical anchors being installed by crane.

The 32 metre anchors were the longest ever installed by Cintec and amongst the longest in the world.

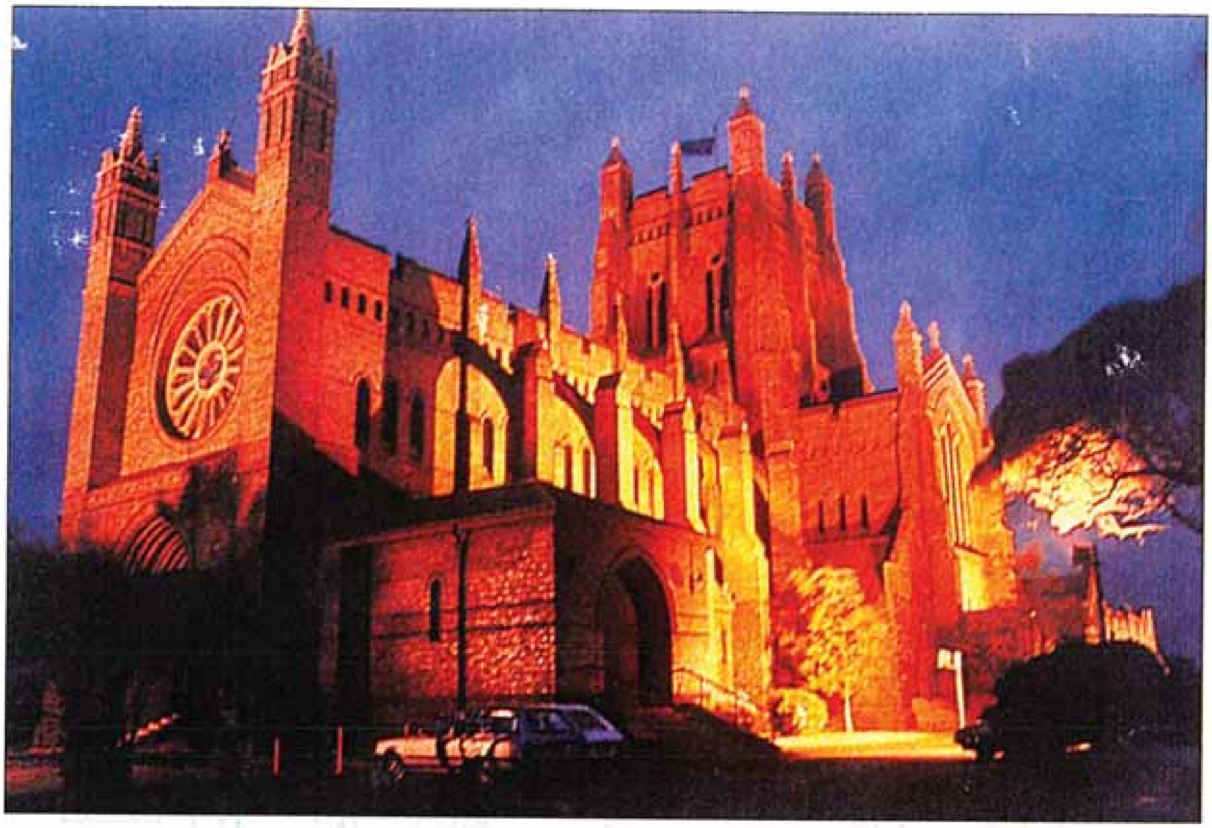
Water could not be used for drilling because of the damage it could do to the building, so all drilling was carried out with non-coring, polycrystalline diamond bits using air for cooling and cuttings removal.

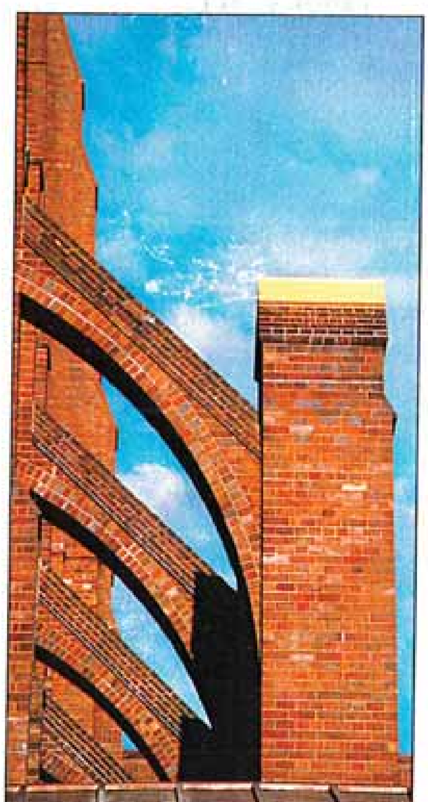


Down-the-hole video was used to verify the integrity of all drill holes and each hole was surveyed for its full length using techniques specially developed on site by the surveyors.

CASE HISTORY

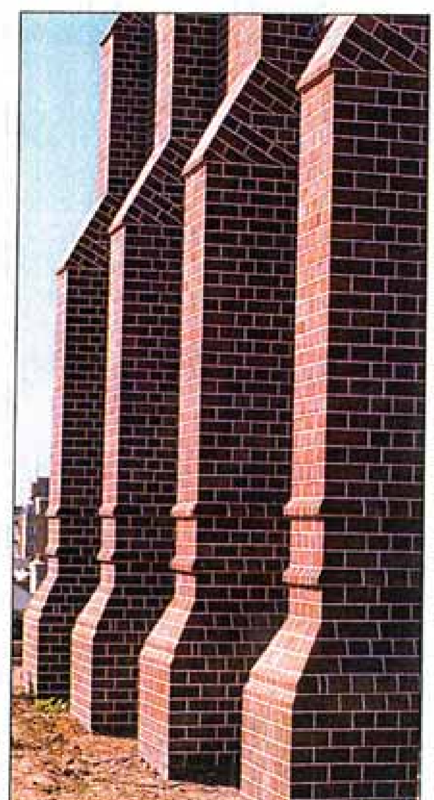
CHRISTCHURCH CATHEDRAL NEWCASTLE, NEW SOUTH WALES, AUSTRALIA. RESTORED





The Cathedral has enjoyed a unique position as a focus for the lives of the people of Newcastle, the region and in many respects the State and Nation in terms of tourism and the perception of Newcastle as a city.

Its restoration, in some part due to the unique capabilities of the Cintec anchor, ensures that the edifice has returned to its former glory and is stronger, and ready to face another 100 years.



CASE HISTORY

FENCHURCH STREET RAIL STATION, LONDON, U.K.

Cantilever Signal System

Viaduct

Fenchurch Street Station is one of London's busiest rail stations; it is the start point and terminus for the main tracks from the South of the U.K. to London. The construction itself is a remarkable example of Victorian 'railway' Architecture and was built at the height of rail travel era. The tracks carrying the service to the station travel over a Victorian Viaduct, comprising a series of arches. These arches support the cantilever system of signalling that guide trains to and from the station. The structure is a large steel gallows extending out over the track, with the signalling system suspended from it. The engineer had to recognise that any work on the structure had to address the problem of a live track running overhead.

The Problem

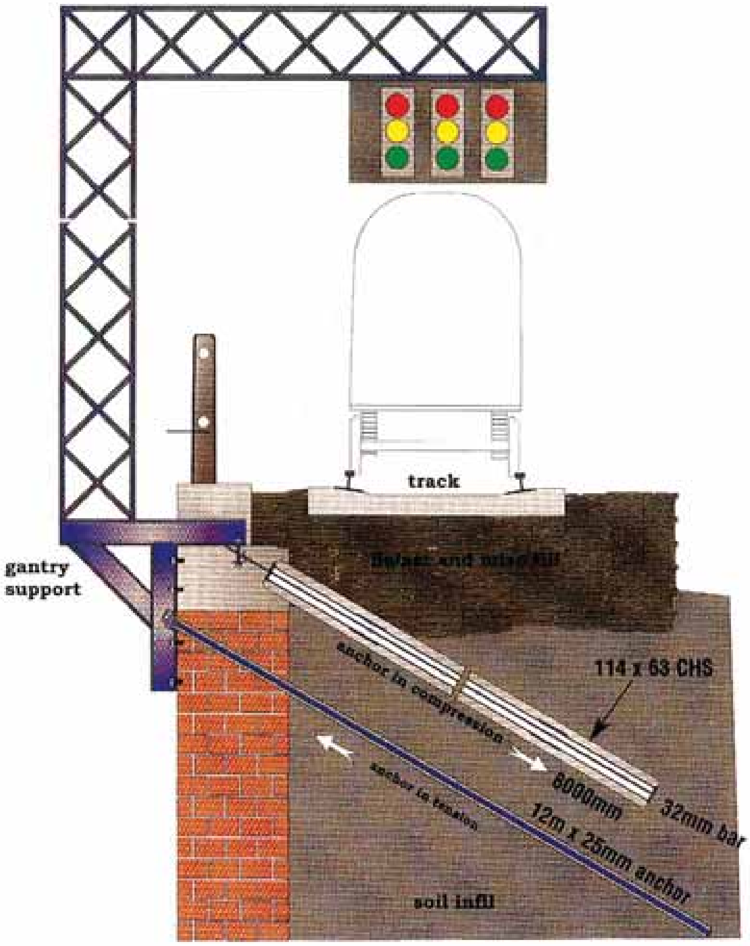
A system was required to secure the gallows to the bridge arches; in their preliminary planning, Railtrack anticipated a shut down of the tracks for 6 weeks. Such a closure would mean a chaotic time table, irate passengers and a loss of revenue. The CINTEC Anchoring System proposal provided a solution that would require only 2 days of rail shut down.

The assembling and installation of a compression anchor

The torqueing of the anchors

CASE HISTORY

FENCHURCH STREET RAIL STATION, LONDON, U.K.



FOUNDATION DETAILS OF ANCHOR ARRANGEMENT TO SIGNAL CANTILEVER FOR BRITISH RAILWAYS AT FENCHURCH STREET STATION LONDON

Shear anchors shown at the top and tension anchors at the bottom

The Solution

The proposed solution involved three CINTEC Anchor types. The central one was a compression anchor of stainless steel comprising a 32mm shell rebar inside a 114 x 6.3 CHS installed in a 200mm hole, 8000mm deep, at an angle of 30 degrees to the horizontal. Below it was a tension anchor, comprising a solid stainless steel body, 12m x 25mm installed in a 50mm drilled hole, and attached to the gantry support to prevent any rotation. Two smaller shear anchors 20mm x 800mm were similarly installed to complete the support. Load tests were carried out, with the placing of a 20m steel beam in position.

As a result of the use of a CINTEC installation, disruption was reduced from 6 weeks to 2 days together with a 50% saving on the original budget Railtrack had allocated to the project.

Testing

In shear

In tension