RECENT DEVELOPMENTS IN MASONRY ANCHORS

by

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CINTEC®

DESIGNED ANCHOR SYSTEMS FOR THE CONSTRUCTION INDUSTRY

Reprinted from "The Construction Specifier", September 1991

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by Martin E. Weaver

I try not to recommend materials or products that I haven't had firsthand experience with; however, an engineer colleague recently drew my attention to a series of masonry stabilization products so seemingly effective that I thought specifiers should be aware of them.

These are not new, untried products. They were first used in 1965 in Switzerland by their inventor Alfons Harke, a distinguished West German engineer. Since then, a long series of variations has been developed and used successfully across Europe, particularly in the United Kingdom, where they are now manufactured. The first North American application, which took place in Ottawa, Canada, in June of this year, involved stabilizing the limestone rubble walls of mid-nineteenth century St. Anne's Church.

Current Methods for Stabilizing Masonry

Unstable masonry is common in historic buildings. Often, inner and outer wythes of what appear to be thick walls are separated by more rubble, voids, or other disconnected masonry. The problem is most common in massive stone walls where a veneer of ashlar or other dressed stone is built over a rubble core, with all the masonry units set in a lime-based mortar.

Prolonged exposure to water from leaking roofs, gutters, joints, ledges, and cracks removes the lime and leads to a gradual separation of the masonry. In classic examples, the ratio of width to height—the slenderness ratio—becomes excessive; a wall suddenly becomes too slender to stand without buckling because only perhaps one-third its original thickness is left to carry the load. Ultimately, the wall collapses.

Similar problems occur following settlement or other types of movement: masonry veneers, arches, lintels, and quoins crack away from the structure behind and peel off.

Two solutions to these problems, frequently used together, have been developed in the last 20 years. The first consists of drilling holes into the masonry and inserting rods or anchors that are fixed by various means. These anchors, in essence, reattach the parts of the wall to one another.

The second solution consists of injecting cementitious grout or synthetic resin as a liquid or semi-liquid. These solidify and restore the integrity of the masonry that was lost when the mortar was removed or deteriorated.

In recent years, embedded anchors of ordinary structural steel in severely polluted environments have been subject to disastrous corrosion and associated disruptive expansion. Stainless steel has become the preferred anchor material as a result. The tendency is to substitute AISI Type 316 for AISI Type 304 because of the latter's lack of resistance to atmospheric pollutants, particularly chlorides.

Current masonry stabilization methods suffer from a number of problems that until now had uncertain solutions:

- They often are difficult to implement satisfactorily in weak substrates.
- They sometimes don't work in repairing poor-quality materials.
- None can be used with certainty to bridge multiple cavities.
- Often, there is no way of knowing whether the grout or consolidant has penetrated the full length for every anchor.
- There is no infallible way of determining whether the grout or consolidant has leaked away through hidden cracks and voids, leaving the anchors improperly attached to the materials they are supposed to be reinforcing or reattaching.

A NEW ANCHOR SYSTEM

The Cintec anchor system (manufactured by Cintec North America in Baltimore and Ottawa) is aimed at many of the problems associated with conventianal stabilization techniques.Reportably , it

- is easily fixed, even in weak materials
- works with inferior materials and is capable of bridging cavities
- is sympathetic with existing structures
- is versatile, quickly made, and permanent.

The basic system, protected by international patents, is ingenious and elegant in its simplicity. The main steel body of the anchor that carries and transfers loads is completely surrounded by a fabric

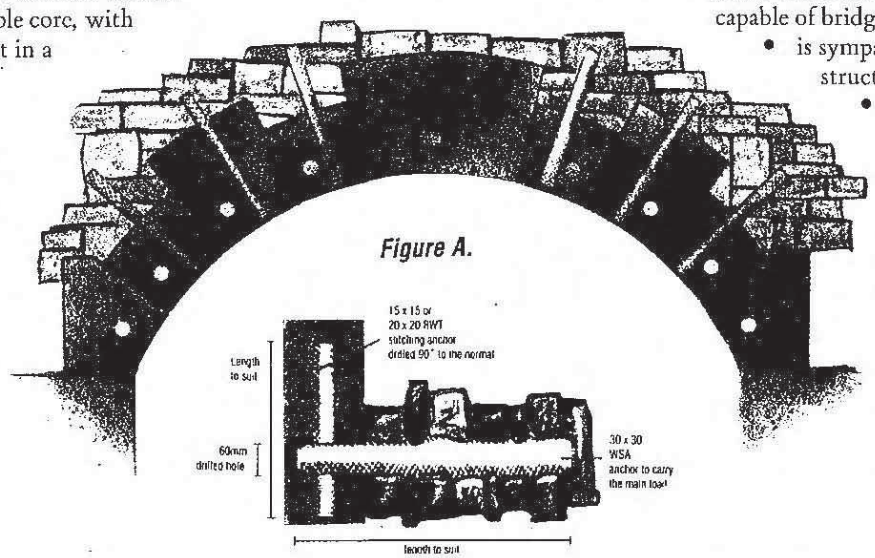
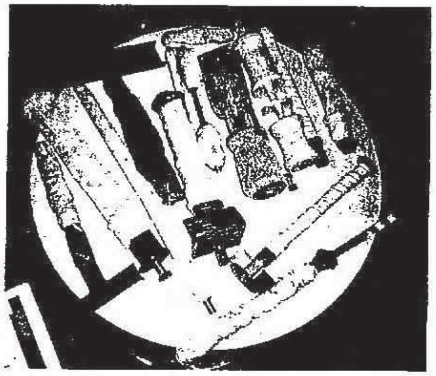


Figure A.

sock made of polyester fibers. This wrapped anchor is placed in a hole drilled to roughly twice the anchor's diameter. Cementitious grout is injected under pressure through the middle of the anchor. When the grout reaches the end, it flows through a series of grout flood holes into the fabric sock. The entire assembly then inflates like a balloon *(see Figure A)*.



Anchors of various sizes and shapes are available to meet designers' requirements.

The excess "milk" of the grout and bonding agent passes through the fabric sock, both fixing and providing mechanical and chemical bonds to the parent material. Variation in the size and shape of the individual components enables the basic method to be altered to meet the designer's requirements.

The socks can be manufactured in various standard sizes, from 20mm to 300mm (¾-inch to 12 inches) in diameter. The mesh size and the amount of expansion can both be varied depending on the application.

The strengths of the materials to be restored and the loads involved determine the anchors' required capacity. Design checks on the parent material's capacities can be based on the resistance strength of the in situ construction to the anchor force according to standard tests. When the parent material or mortar strengths are unknown, the capacity of the material/mortar can be determined from field tests of the anchor. The strength of the anchor to resist the load depends on its cross section. If the anchor is a solid bar, it may be deformed. If it is a tube, it may be crimped. On square-section material, a circular plate almost the size of the bore hole is welded to the anchor at both ends to ensure the full grout strength is exploited.

Installation

Presstec, the grout normally used with the system, is a one-component mix of non-staining, sulfate-resisting portland cement, graded aggregate, and additives that make it pumpable and strong and that minimize shrinkage.

Current British formulae specify 6 litres of water per 25kg of Presstec to produce a free-flowing grout with a pot life of 45 to 60 minutes, depending on ambient temperatures. With an ambient temperature of 68°F (20°C) at 65 percent RH, initial set is obtained in two hours and 40 minutes, final set in three hours. After five hours the grout has been reported to develop a compressive strength of 203 psi; after one day, 3,335 psi; and after 28 days, 5,800 psi.

Minimum tension and compression strengths of standard anchors are based on steel capacity subject to the strength of the parent material and embedment length but may vary from 0.9 to 14.9 kips. Shear strengths of anchors are similarly dependent, and minimum values range from 0.54 to 5.1 kips.

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The length of the anchors also varies, depending on the application. Stitching anchor applications of up to 30 feet (9 metres) in length have been used regularly. Typical applications include stitching walls horizontally parallel to the wall face across vertical cracks, stabilizing brick arches by stitching parallel to the wall face, and anchoring retaining walls and harbor walls. A few years ago, 98-foot-long (30-meter) anchors were used to stabilize the harbor walls at Zeebrugge, Belgium.

Drilling is typically carried out using diamond-tipped coring bits that cause minimal vibration. Although drilling is normally with water or air-mist supplies, special techniques for dry diamond drilling have been developed for situations in which lubricating/cooling and dust-suppressing water could cause problems in delicate masonry or adjacent interior finishes.

According to the manufacturers, the basic principles of the fixing permit the designer to create individual fixings to meet particular requirements. Variations on the basic theme and applications are constantly being introduced, but the success of the anchors is based on appropriate design and application and on careful installation, treatment, and handling of grout and anchors from the moment of their arrival on site. The manufacturers offer training to ensure safe, appropriate drilling, installation, and grouting. □

Note

1. Consulting engineers Anrep Associates Ltd., Toronto and Ottawa.

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Acknowledgement

The author wishes to express his thanks to Robert Lloyd-Rees of Cintec Canada, Tel. 613-225 3381 and to Liam O'Hanlon and Rory Gibbons of Ove Arup and Partners Consulting Engineers P.C., New York, Tel. No. (212) 229 2669.

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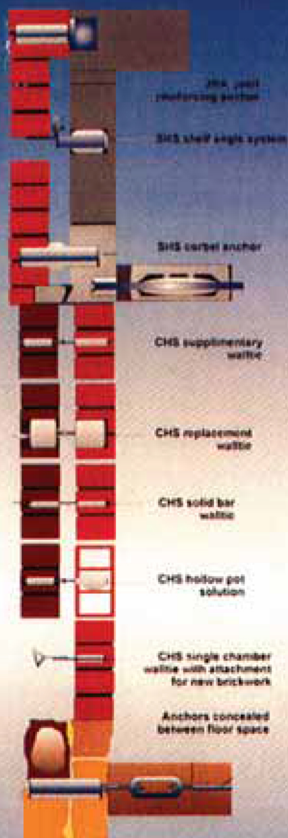

- Designed to the requirements of each application
- Quickly installed
- Age tested for durability
- Fire resistant
- Cementitious, therefore sympathetic to the original structure
- Controlled grout flow & containment
- Invisible when installed
- Effective for structural repairs, ground anchoring, parapet walls & masonry arch strengthening

This brochure offers a simple guide to the standard applications undertaken with the Cintec Anchor System. It does not give detailed technical information necessary for a specific design, but indicates the types of problem solvable within the design parameters of the system. Cintec has both in-house and contracted engineers offering advice and providing the entire design work without initial consultation fees. The cost of specialist engineering advice is normally incorporated in the final anchor price.

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