Structural anchor advances

New European legislation has made it more important than ever that engineers and specifiers understand if products are fit for purpose.
Structural anchor advances special report

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Introduction
By Alastair Soane

Anchors are key components in many structures and may be part of safety critical systems. In recent years the fixings industry has identified potential problems with the selection and installation of their products and have taken steps to improve awareness of correct procedures.

The use of anchors ranges from carefully planned and executed installations that are integral with the permanent works to one-off applications as a quick fix for an immediate problem. There is often an impression that resins have magic properties and can be used in any circumstances to produce a permanent and strong bond for anchors or to replace missing rebars.

Records show that there have been many anchor failures, some resulting in fatalities including lining failures in the Boston Big Dig tunnel (2006), Japan’s Sasago tunnel (2012) and the Balcombe rail tunnel in the UK (2011) which was a near miss.

CROSS (Confidential Reporting on Structural Safety) newsletters have also reported a number of heavy ceiling failures in cinemas and other venues which could have caused tragedy. Sudden, catastrophic, and progressive collapses have occurred where a single fixing has failed, sometimes after many years, and the additional load thrown onto adjacent fixings causes them to fail in sequence.

The reasons for most problems are known and plenty of good advice is available on the selection, installation, and testing of new anchors. In 2012 a new British Standard, “BS 8539:2012 Code of practice” was published for the selection and installation of post-installed anchors in concrete and masonry. Further information is given at www.structuralsafety.org including the recently published “Alert: Tension systems and post-drilled resin fixings”.

Alastair Soane,
Director, Structural-Safety

Foreword
By Mark Hansford

Construction products are not commodity products. They are safety critical.” So Jan Coumans, technical commission chairman of the European contractors federation FIEC told European Commission officials at a stakeholder conference late last year.

The conference was convened to discuss a shift in legislation around the certification of many construction products through the 1 July 2013 replacement of the Construction Products Directive with the Construction Products Regulations (CPR).

It’s a complex piece of legislation. Fundamentally designed to make it easier to get new products to market, the repercussions are still being worked through. Concerns are that it will now be easier to shift sub-standard products – certainly that was the concern being raised by Coumans at the conference.

He fears that the move will trigger an increase in structural failures, for which contractors will be held accountable.

At the core of the change is the subtle rebranding of the already poorly understood acronym ETA. Instead of having to demonstrate a product’s fitness for purpose in use in order to obtain a “European Technical Approval”, manufacturers now must simply demonstrate that the product meets certain performance criteria as set out in a “Declaration of Performance” in order to receive a “European Technical Assessment”. It’s created confusion.

“One expectation of CE marking and [the acronym] ETAs is that they confirm that the product meets a given specification,” admits Rainer Mikulits, managing director of the Austrian Institute of Construction Engineering and president of the European Organisation for Technical Assessment (EOTA), the European Commission-backed body responsible for running the assessments programme.

“That is no longer the case. It just confirms that a product conforms with a declared performance criterion. It is a change in philosophy and it is a concern,” he says.

Mikulits questions the decision to give the manufacturer the power to decide which specific properties of his product would be tested.

“It is a little bit like Christmas. The CPR states that ‘the performance of these essential characteristics is to be agreed by the manufacturer and the assessment body.’”

“The ETA is no longer an assessment of the fitness for use.”

What it means is that now, more than ever, it is important to understand what creates a quality product. Because whatever the legislation, products like chemical and mechanical anchors are safety critical – used widely for a multitude of purposes from holding up suspended ceilings in tunnels to holding down crash barriers alongside motorways.

Read on to find out more about the regulatory changes, and what you can do to ensure that the products you use or specify are fit for purpose.

Mark Hansford,
Editor, NCE
Tight grip

Securing anchors
By Mark Hansford

The traditional way to install chemical anchors is to inject an epoxy resin into a prepared, dust-free hole and then install an anchor rod through, say, an endplate.

Once the resin hardens, the fixing is complete. The process imparts no stress into the base material during installation, so is the ideal solution for multiple fixes that have to be located close together or near edges.

Its only downside is that the quality of the bond relies heavily on the preparation of the hole in the base material—the hole must be completely cleaned of drill dust.

“Preparing a hole for a chemical anchor is the most critical step in the installation process, which usually varies from one supplier to another,” explains Hilti anchor product manager UK Mark Fort.

“After drilling the hole, the installer has to blow out loose particles of the base material using compressed air. The remaining, more compacted particles in the hole then have to be loosened using a wire brush, and the loosened particles removed again by blowing air into the hole.”

Depending on the type of resin used, this “blow-brush-blow” process for hole cleaning usually needs to be repeated twice; and for some resins, suppliers require repeating it up to four times. This effort-intensive process not only doubles the time it takes to install each anchor, but exposes the installer to dust particles.

Since this is the procedure used for the anchor’s load testing, Fort explains, if holes are not prepared properly, the load capacity of the fixing will be drastically reduced (see Graph 1). Concern that such anchors could fail at less than design load has led designers to take a conservative approach by either over-specifying the design loads or adding redundant fixings to account for the possible loss in capacity.

For extremely risk-averse sectors such as the nuclear industry, the installation procedure for chemical anchors is considered very critical.

Andy Hurst, senior structural engineer for consultant Atkins’ nuclear business, says: “With chemical anchors, you are reliant on a third party to ensure the bond is correct. If the hole isn’t prepared properly then the anchor—particularly if it is installed to the underside of a slab—could drop out.”

The good news for designers with concerns about the installation of chemical anchors is that Hilti, after many years of research and testing, has developed a solution, the CE-marked HIT-HY 200 SAFEset system, which is designed to reduce potential errors during the installation of chemical anchors.

The HIT-HY 200 SAFEset system guarantees load capacities, without the need for hole preparation. This ETA-approved solution offers two installation methods, one using the Hilti HIT-Z anchor rods, the other using Hilti’s TE-CD and TE-YD Hollow drill bits.

Hilti HIT-Z anchor rods come with a cone-shaped helix, which works as a torque-controlled bonded anchor. This means that the performance of HIT-Z rod, when used with the HIT-HY 200 injectable mortar, is unaffected by uncleaned holes, both in dry or water-saturated concrete (see Graph 2).

The hollow drill bits make subsequent hole cleaning completely unnecessary. Dust is removed while drilling is in progress using a universal vacuum cleaner. Then the HIT-HY 200 mortar is injected in the clean hole and a normal threaded rod or a steel reinforcement bar installed. This method not only saves time compared with traditional wire-brush hole cleaning, but also means a virtually dust-free working environment.

The introduction of SAFEset means designers now have a reliable solution that eradicates concerns about hole preparation, gives the assurance that the load capacities will be achieved in accordance to the ETA approval documents, and improves productivity by eliminating the most tedious step of anchor and rebar installation.

“Specifying the HIT-HY 200 SAFEset system gives designers the confidence and peace of mind that anchor fixing and rebar will perform onsite just as has been designed on the drawing,” says Fort.

Graph 1: THREADED ROD

Graph 2: HIT-Z ANCHOR ROD

Fixed: The HIT-HY 200 SAFEset system in action
Post-installed rebar connections for concrete slab, column or wall extensions.

Heavy duty anchoring in cracked or uncracked concrete, e.g. for steel beams, columns, manufacturing equipment or ledger angles.

Facade installation, steel and metal construction, installation of railings and safety barriers.

**NO CLEANING REQUIRED: HIT-Z ANCHOR RODS**

When the rod is torqued, the surrounding mortar cracks, allowing the rod to act like an expansion anchor.

Expansion forces significantly increase friction against the sides of the borehole. This results in a torque-controlled adhesive expansion anchor system that takes up the highest possible loads in cracked concrete with no drop in performance under demanding conditions such as in wet or dry uncleaned holes.

- Anchor diameter range: M8 to M20
- Material: Carbon or stainless steel (A4)
- Embedment depth: Up to 12 times rod diameter
- Concrete compressive strengths: C20/25 to C50/60
- Installation temperature range: 5°C to 40°C

**HOLES THAN CLEAN THEMSELVES: HOLLOW DRILL BITS**

When using a standard drill bit, compacted dust prevents a stable joint between the mortar and the base material.

This dust must be removed by brushing and flushing with compressed air before injecting the mortar. Drilling with a hollow drill bit connected to a universal vacuum cleaner removes the dust at the point of impact, meaning no additional steps. This ETA-approved installation method eliminates the most time-consuming and load-affecting step in the installation process, whilst reducing exposure to harmful dust inhalation.

- Rebar diameter range: ø8 to ø25
- Threaded rod diameters: M10 to M24
- Embedment depths: Up to 400mm
- Concrete compressive strengths: C20/25 to C50/60
- Installation temperature range: -10°C to 40°C
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