Structural anchor advances

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

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.structural-safety.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.

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Proof of the pudding

Testing
By Mark Hansford

A product has to be convincing to be successful, and nothing convinces more than a live test.

CE marked or not, it is clear that there is no substitute for testing when it comes to providing reassurance that a product will do what it says it does.

UK fixings manufacturer Hilti takes this message seriously and internally tests, evaluates and manufactures non-CE marked products to the same exacting standards as those applied to products requiring CE mark certification.

Much of the testing work for fixings like chemical anchors is done at its Kaufering plant, just west of Munich in southern Germany.

There, testing is done that far exceeds any European standard, and manufacture takes place in a laboratory-like environment. Testing includes subjecting anchors to sustained whole-life load terms and extreme corrosion environments.

A tour of the plant shows the attention to detail: from the extra testing in the test centre to the batching plant where resins for the chemical anchors are made on site to ensure they are of the highest quality.

But nothing convinces more than an independent seal of approval, and an hour's drive north takes you to Augsburg and the Kiwa test house.

Kiwa is a fiercely independent certification body; it is not involved in manufacturing, trading or any other activities that might endanger its impartiality. Test engineer for fastening technology Kerstin Clute explains: "There is no external influence on our decisions regarding the outcome of our activities such as certification and testing."

With such a commitment to independence and operations in 50 countries worldwide, Kiwa is a notified body for the purposes of the Construction Products Regulations. This means it is qualified to test products' conformity with their Declaration of Performance and the European Technical Assessment (ETA) requirements.

It should come as no surprise that it is the go-to test house for Hilti and many other responsible manufacturers.

"We test about 10,000 anchors a year here, mainly from German manufacturers," says Clute, adding that it is not a question of pass or fail, but "whether they reach the load capacity expected".

Anchors are tested by independent laboratories to come up with the rated capacity – that is the amount of load in tension and shear that an anchor can carry when installed according to the manufacturer's instructions.

It is a rigorous procedure, explains Clute, with up to 60 test series per anchor size carried out on a product before a certificate can be issued. For Hilti's HIT-HY 200 injectable mortar, for example, it took one year to complete all the tests required.

"And special cases can take longer," she notes.

The HIT-HY 200 injectable mortar took time because of the extraordinary performance Hilti was seeking. This latest generation of adhesive mortars, together with the firm's cone-shaped HIT-Z anchor rods, are designed to deliver a step-change in chemical anchor systems by eliminating the need for hole cleaning before installing the anchor.

Working together as the SAFEset system, Hilti was hoping to prove that the anchors would achieve impressive load values in cracked and uncracked concrete, regardless of hole cleaning.

But because it was a new system, a new test regime had to be approved, explains Clute.

Variety: Up to 60 tests per anchor size are carried out

> **"We test about 10,000 anchors a year here, mainly from German manufacturers"**
> Kerstin Clute, Kiwa

"Normally we test with complete hole cleaning, partial hole cleaning, no hole cleaning; both with saturated concrete and with dry concrete," she explains. "With the HIT-HY 200 and HIT-Z, two different guidelines influenced the test – one for adhesive

Exhaustive: Anchors are tested to failure load in laboratory conditions

mortars and one for anchors – and so it was a new test."

The European standards body had to consider the proposed approach, and approval was duly granted. And new system or not, it was the cracked concrete test that was likely to prove the toughest, says Clute.

For the cracked concrete test the anchor is first installed in accordance with manufacturer instructions in a deliberately-created hairline crack in a concrete beam.

The beam is then subjected to 1,000 load cycles of between 200kN to 650kN to create a fluctuating crack width of 0.1mm to 0.3mm. Then the moment of truth – the anchor is tested to failure load.

"This is normally the killer test," says Clute. "Normally if it passes this test, the product will pass."

Hilti's did, which is as well, given that the process is no small financial commitment. Typically, to test one anchor with one size costs £36,000 to £60,000. To test six sizes – a typical range for one product – you are looking at £240,000. Going back to the drawing board is not cheap.

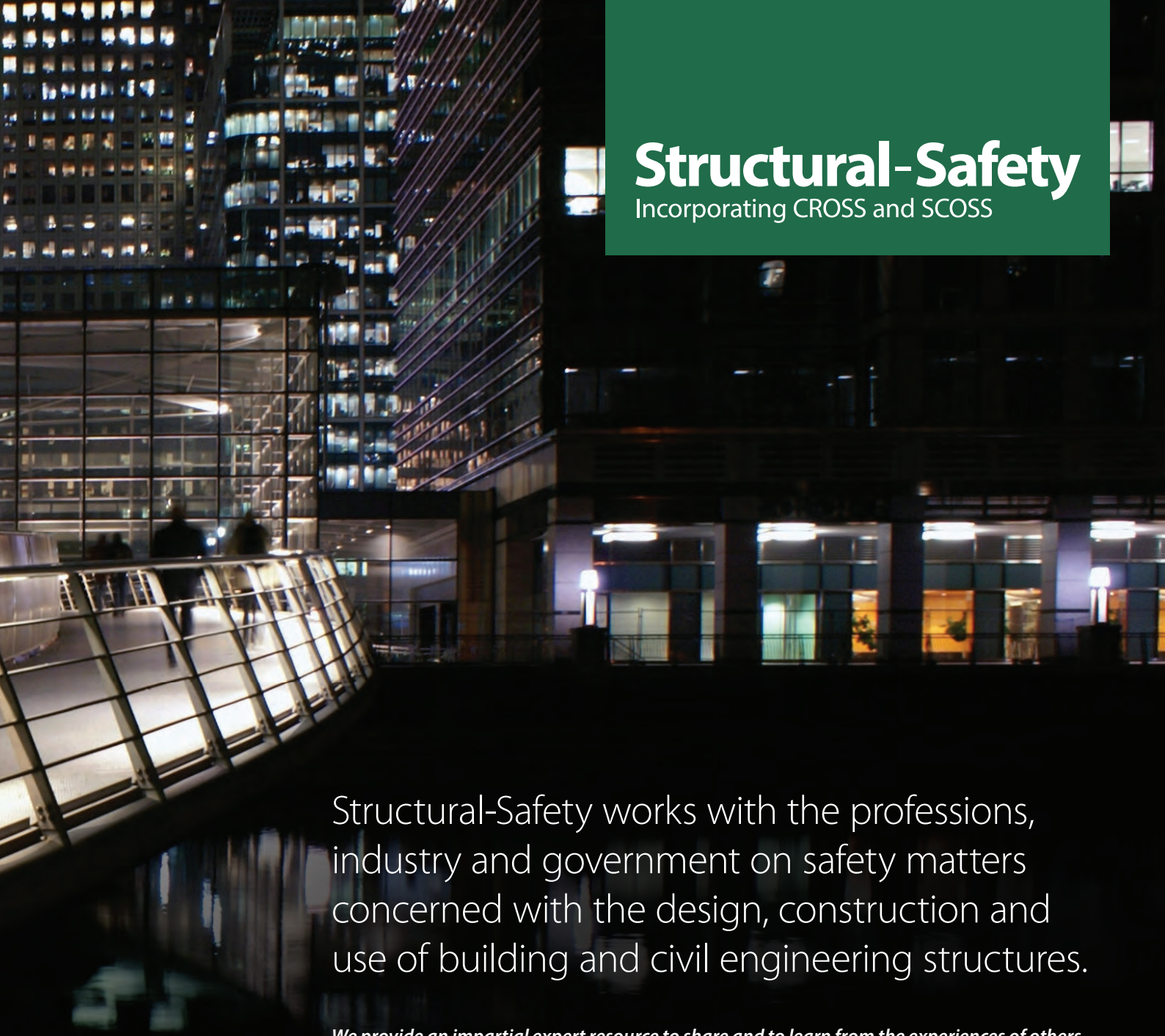
And of course for most anchors used in the construction industry none of this is compulsory – but Clute for one has seen enough in the laboratory to recognise the value of the ETA process. "I think the ETA is important," she says.

But she warns that just because a product has an ETA that is no guarantee of safety.

"Anchors are safety critical. You just can't have enough testing"
Mark Fort, Hilti

"We clean holes to the manufacturer's specification. And the cleaning method is documented in the ETA. But of course on site it is often quite different," says Clute. "Dust in holes is the reason that anchors fail. That's why, for chemical anchors, hole-cleaning is so important."

Dust in the hole acts as a bond-breaker for adhesive anchors. That's unless you are using the HIT-HY 200 SAFEset system (see pp10-11). "Anchors are safety critical. You just can't have too much testing," says Hilti anchor product manager UK Mark Fort.



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