

# CROSS

## Confidential Reporting on Structural Safety

### Newsletter No 24, October 2011

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Reports sent to CROSS are de-identified, categorised, and sometimes edited for clarification, before being reviewed by the CROSS panel of experts. The panel makes comments that are intended to assist those who may be faced with similar issues. In the Newsletters the reports are shown in black text and the comments are shown below these in green italics. Reports and comments are also given on the web site data base.

Please [click here](#) for link to CROSS website

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## INTRODUCTION

This Newsletter is the first to be published on the new Structural-Safety web site ([www.structural-safety.org](http://www.structural-safety.org)) which combines the activities of SCOSS and CROSS. For those who were receiving publications from either group there is no need to re-register, and those who wish to register for the first time will find a link on the home page of the new web site. The need for continued vigilance has been illustrated in recent weeks with the dramatic and deadly collapses of two major temporary stage roofs: one in Indiana USA, and one in Belgium, with a total of eleven fatalities and many injuries, and several other recent collapses of similar structures. The subject is being considered by SCOSS and their views will be published in due course. There has also been the collapse, with two deaths, of a cantilever stadium roof being erected in Holland, the death of a man in London from falling masonry, and the collapse of a large canopy under construction at a UK school with several injuries.

Reports in this issue of the Newsletter start with the comprehensive description of design error provided by a major firm of consulting engineers. This is much appreciated as it has been provided with the full backing of the company concerned. CROSS is a platform for sharing information without revealing names or identifiable details and the more widely CROSS is trusted the more effective it will become. Other reports deal with construction issues including tower crane bases, the care needed when using certain epoxy grouts where there are high ambient temperatures, another retaining wall failure, and more concerns about lack of control and supervision on sites.

DRD Roads Services in Northern Ireland have become the latest Government Department to join CROSS as a backer and this follows the arrangements already in place with the Highways Agency in England. Their Safety Management Procedures now include a section on the confidential reporting scheme and any issues that would help with lessons to be learned will be passed on through senior management. The Department is responsible for:

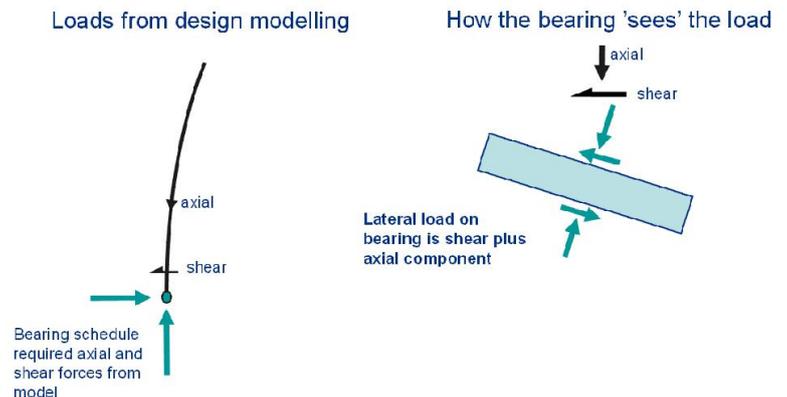
- regional strategic planning and development policy;
- transport strategy and sustainable transport policy;
- provision and maintenance of all public roads;
- public transport policy and performance;
- certain policy and support work for air and sea ports; and
- policy on water and sewerage services and management of the Department's shareholder interest in Northern Ireland Water.

**The CROSS programme depends on receiving reports and individuals and firms are encouraged to participate by sending concerns in confidence to [structural-safety](http://www.structural-safety.org).**

## ASYMMETRIC BRIDGE DESIGN AND CONSTRUCTION – A NEAR MISS (Report 262)

During the construction stage of an arch footbridge, says a reporter, a design error was identified that had been indirectly revealed by an associated error in construction. It is reported that effective correction of these errors was expensive but resolved the potential performance safety issues. The bridge was designed to be constructed from four precast concrete arch legs, two each side which were to be cast integrally with an insitu deck to create an open spandrel arch elevation with two legs on each side supported on spherical bearings. The bridge was skew and curved in plan. The legs tapered longitudinally and, in order to aesthetically enhance the simplicity of the elevation, had skewed cross sections. The bridge was designed using a 3 dimensional frame model with grillage type members representing the deck, and beam members representing each leg. Pinned supports were positioned at the deck ends and at the base of each arch leg. Reactions from the analysis model were aligned to the global axes and would therefore not be suitable as input into the bearing schedule without translation to the proposed local axes of the bearing.

The drawings being prepared for the arch springing area were given a lot of attention but this was focused on the aesthetic and construction aspects. However, although the designer correctly extracted forces from the model, it is believed that he gave insufficient attention to the drawings being prepared and how they communicated his design. Consequently he did not realise that the bearings were shown to be aligned parallel to the plan skew of the bridge and not perpendicular to the line of thrust from the arch legs as was his design intent. The error was compounded by the checker who suffered a similar lack of appreciation of what was shown on the drawings and agreed the design to be correct. See the diagram below.



Whilst dealing with construction issues related to the casting of the arch legs a senior engineer noted the anomaly between what was shown on the drawings and the figures in the bearing schedule and, after investigating the design calculations, concluded that the actual lateral load on the bearing would have been some four times greater than required by the schedule. Although the bridge legs had not been erected they had been cast. The construction error, which involved incorrect reinforcement layout, had already necessitated the decision to recast the legs. It was at this stage that it is reported that the design error was detected. It also provided the time window to revise the leg end geometry to eliminate the undesirable component of lateral reaction and restore the original design intent. It was however necessary to undertake some challenging re-modeling of the bridge foundations that were already cast. The discovery of the design error

### What should be reported?

- concerns which may require industry or regulatory action
- lessons learned which will help others
- near misses and near hits
- trends in failure

### Benefits

- unique source of information
- better quality of design and construction
- possible reductions in deaths and injuries
- lower costs to the industry
- improved reliability

### Supporters

- Association for Consultancy and Engineering
- Bridge Users Forum
- British Parking Association
- Communities and Local Government
- Construction Industry Council
- Department of the Environment
- DRD Roads Services in Northern Ireland
- Health & Safety Executive
- Highways Agency
- Institution of Civil Engineers
- Institution of Structural Engineers
- Local Authority Building Control
- Scottish Building Standards Agency
- UK Bridges Board

was fortuitous. If there had been no issues with the precasting of the concrete legs, the additional load on the bridge support would probably have remained undiscovered until the temporary works for the insitu deck were released. Under these circumstances the bearings would have experienced significantly larger lateral loads than they were designed for. This may have led to the safety or the performance of the bridge being compromised. It is however more likely that the overloading would have manifested itself before the falsework was fully released giving an opportunity to reinstate temporary support and thus address the issue. This would, however, have left the considerable problem of restoring the bridge to a safe condition. Overall, the errors resulted in significant costs and delay to the works on site. However, the bridge was duly safely constructed and is now complete and in service.

Once the problem had been resolved, a programme of dissemination within the company of the issues involved and lessons learnt was undertaken. This improved awareness of the problems that can arise in structures with complex and unusual geometry. During the initial dissemination of the information, it became clear that others had experienced problems when designs involved bearings with non-vertical axes. This highlighted the challenges of ensuring that lessons from experience are not lost. A further difficulty in preventing the reoccurrence of errors became apparent when considering the wider implications. It is relatively straightforward to warn of the issues of bearing alignment in precast concrete arches and to have good confidence that the same error should be avoided in future bridge designs. However, the post project reviews of this particular lesson have also emphasised the need for greater global awareness. It was evident that there was a need to identify where a similar issue could occur in a different structural form or context. Consequently an extensive series of presentations and workshops have been organised within the company to widely disseminate the key lessons learned.

### CROSS comments

*The provision of this report from a major consulting firm is much appreciated and illustrates how lessons learned within an organisation can be shared amongst the wider engineering community. This is a case of identifying a precursor to a potentially more serious event which is one of the most effective ways of preventing failures. The use of analysis software must include recognition of the limitations of the*

*tool being used and the contributors of this report should be applauded for their willingness to open their processes up to external scrutiny. The issue is by no means unique and represents a problem with analysis where some software cannot deal with skewed reactions. There are ways of dealing with this issue and it is very important that the boundary conditions are understood by the engineer carrying out the analysis and due allowance made. There is a generic set of problems when translating a complex computer analysis into reality. Perhaps it underscores the need to always carry out parallel hand checks to ensure output is of the right order; especially at interfaces. Whilst traditional checking is an established way to comply with QA procedures and has a valuable role, it may not always be foolproof. In a 2009 Topic Paper SCOSS recommended independent review through the peer assist process (<http://www.structural-safety.org/view-report/scoss5059/>) whereby reviews are undertaken by experienced personnel who, from experience, can direct appropriate enquiries.*

## FALSIFICATION OF RECORDS

CROSS has had some reports about false documentation in relation to materials or components and would be interested to hear of other experiences about this practice. The SCOSS committee is considering the matter and will consider all information sent confidentially to CROSS.

## NEWS ITEM

### Falling masonry kills man at restaurant

Falling masonry kills man at restaurant

In August 2011 a 27 year old man was killed by a piece of falling masonry while having a drink outside a London restaurant. Part of a stone column broke away from the front wall of the restaurant and crashed through an awning above him.

### CROSS comments

*In Scotland in 2003 a report was published by the Construction Industry Council for Scotland on 'Risks to Public Safety from Falling Masonry and Other Materials'. This followed the death in 2000 of a young woman as a result of coping stones falling onto her from a third storey roof above a bar in Edinburgh. The Scottish Government then commissioned CROSS to collect and analyse information from Local Authorities in Scotland on materials and debris that had fallen from buildings. The final report is: [Confidential Reporting on Structural Safety for Scottish Buildings \(SCOTCROSS\)](#) and gives information on the number and frequency of falls of masonry and other materials related to various parameters. There have been a number of deaths and injuries from this cause in England over the years but it is not thought that there has been a study similar to the Scottish example.*

## NEWS ITEM

### [Review of international research on structural robustness and disproportionate collapse](#)

The Department of Communities and Local Government published a research report in October 2011 which concludes an extensive international literature review into robustness and disproportionate collapse in structures undertaken on behalf of the Department for Communities and Local Government and the Centre for the Protection of National Infrastructure. This report aims to ascertain the state of knowledge in the subject and identify the gaps in that state of knowledge against which future research initiatives can be targeted.

## FOUNDATION BASE PLATES FOR TOWER CRANES (Report 257)

On two different contracts it was observed that the foundation base plates for tower cranes have suffered from low compaction of the concrete on which they rest. It was noticed by the reporter in one instance when ripples were seen in standing water around the base of the mast as a crane slewed. Closer inspection resulted in the detection of a small amount of 'vertical play'. The type of anchor used for this crane depended on threaded bolts and not a steel stool. It was seen that the nuts above the base plate had not rotated so the concrete below must have moved. The bolts had lost some of their pretension so they were re-torqued to the correct value and regular checks were made. There was no need to remove the crane or reduce its working capacity. It would appear that the concrete team who cast the base plates onto the foundation did not take sufficient care to ensure all the air under the plate was removed and that the concrete was well compacted. Some time later at a meeting of construction engineers, continues the reporter, the topic of tower crane foundation was discussed and it was found that another company had suffered the same type of problems but they used a steel stool and not bolts. This meant that they were unable to re-torque the fixing and the crane had to be removed to cure the problem. Concrete teams need to take particular care when casting reinforced concrete crane bases and the engineers supervising the works should find out if the team in question has performed this type of work before and make clear the need for full compaction under the base plates.

### CROSS comments

*There are many examples of cranes failures: particularly tower cranes and mobile cranes, which tend to topple, and the importance of a stable base and sub-strate cannot be overstated. Failure of a tower crane, or indeed any crane, can be catastrophic and this type of event, and its management, is covered in the CIRIA report [Guidance on catastrophic events in construction](#). In planning such work, any assessment of risk should identify 'safety critical' considerations and one of these would be the quality of concrete and its placing and compaction. This should be ensured by appropriate supervision and post-concreting checks. Extra care should be exercised when concreting near cast-in inserts, including anchors, and the subject should be addressed in a method statement by the contractor.*

## FAILURE OF EPOXY FIXINGS DUE TO HIGH TEMPERATURES (Report 244)

Two mobile phone towers were erected on the roofs of two nearby buildings using drilled epoxy anchors into the roof slabs. During a storm of moderate intensity, both towers collapsed; the failure mechanism being the pull out of the anchors from the drilled holes. The recorded wind speed was below the design wind speed for the site (a built up area) and there were no other structural failures in the vicinity. On examination it was identified that the epoxy grout used had a limiting temperature of application of 35°C. Although the temperature at the time of construction was marginally below this, the capsules had been left out on the roof for the best part of a day in the direct sunlight on the black tarmac covered roof. The grout had therefore been subjected to conditions that were well outside its operating limits. The corrective action identified after the failure was to monitor and control the temperature of all chemical fixings, with recognition that ambient shade temperature and exposed surface temperatures on site can be vastly different. The product labelling was not particularly clear on this although with hind sight, the failure could easily have been avoided

## NEWS ITEM

### Hoarding blown onto child (Report 228)

A two-year-old child escaped with minor injuries injury after a 2.4 m high, 17m wide, shop hoarding collapsed on him as it was blown over.



The main contractor and the hoarding sub-contractor pleaded guilty to breaching the Construction (Design and Management) regulations 2007 by failing to ensure that the hoarding was properly designed and built and were fined £4,000 with costs of £5,273, and £4,000 and with costs of £6,963 respectively. No formal design was carried out; therefore no consideration had been given to wind loads or stability. To compound the issue, changes were made to the agreed (albeit un-designed) arrangement when the hoarding was constructed on site. There was no recognition that this was temporary works and so the principles set down in BS5975 were not followed.

#### CROSS comments

Hoardings can be significant structures in their own right, subject to large wind forces and deserve appropriate attention. Inadequately designed free standing walls collapse with sometimes fatal results and the same can happen with hoardings. There is general concern in the industry not just at the risk of collapse, but also at the time wasted in bespoke designs for what is a standard item in many respects. Apparently simple structures are frequently built and perform successfully using rules of thumb based on experience. It is often the case that failure to comply with CDM Regulations result in prosecution when matters on site go wrong. BS 5975 relies heavily on tasks and duties being performed by a "competent person" for whom it gives a long definition. The Temporary Works Forum (TWF) is considering the matter.

through better preparation of method statements and a focus on environmental effects at the time of construction.

#### CROSS comments

The reporter succinctly summarises the situation and the required actions. The strength of epoxies is generally related to temperature. Engineers know about the fatal consequences of the Boston Big-Dig when [epoxy fixing failures](http://www.structural-safety.org/) led to fatalities and massive civil claims. SCOSS has issued an Alert on the subject of fixings which may be found at <http://www.structural-safety.org/>. The construction industry uses some sophisticated materials and compliance with manufacturer's instruction is always essential, not least as otherwise the supplier's liability will be invalidated. Detailed advice on fixings generally can be obtained from the British Fixings Association (<http://www.fixingscfa.co.uk>).

### GENERIC DESIGNS FOR STEEL BEAMS IN DOMESTIC BUILDINGS (Report 245)

The reporter has been approached by an architectural services company to produce generic steel beam designs. He says that load assessment could be done by the company, and then a (possibly) unqualified person refers to the "generic design" for a specified span to check that the assessed load is less than the apparently allowable load given by the programme. This, according to the reporter, is not a safe practice and CROSS should be alerting local authorities to be vigilant.

#### CROSS comments

In a sense this is similar to the use of traditional span/load tables except that a "design" is produced which may not properly represent the actual circumstances. The impression may be given that the calculations are more than an approximation and the risk is that even in domestic property alterations it can be quite challenging to work out a sensible design load. This requires knowledge of structural behaviour, particularly when loads may not be applied in the way assumed in a generic design. There are a number of issues, for example end restraint, lateral loads and possibly lateral torsional buckling which may not be recognised and could make the generic case inapplicable. Traditional load span tables and software set down the scope of their use very clearly so that "interpretation" of use is not required.

### FAILED TWO STOREY RETAINING WALL (Report 240)



A developer built a small estate adjacent to an existing property (shown on the left of the photograph) with a retaining wall between the two. The reporter checked the proposal on behalf of the owner and told the developer that it was not safe and would be dangerous. The builder took no notice so the reporter called the local council who refused to get involved and the wall was built. It was constructed of concrete blocks, was almost two storeys high, and had no reinforcement. Melting snow seems to have been too much for the wall which collapsed moments after someone from the adjoining property had

walked past. The wall fell onto the adjacent property and cracked the end walls, and there is the possibility of further collapse as the surrounding ground is now unstable.

#### **CROSS comments**

*A major concern hereto has been that Building Control has no duty to look at such structures, yet from the many reports sent to CROSS retaining wall failures are common and some are deadly. Examples are seen of completely unsuitable designs and this is one of them. There have been attempts to change the situation but so far without success. All retaining walls can be dangerous and perhaps should be designed by a competent structural engineer unless the walls follow the empirical proportions and conditions illustrated in Approved Document A of the Building Regulations. A call to the HSE might help as this does fall within their remit, but any action may be resource constrained. In the longer term education is part of the answer, but as commercial gains from building irresponsibly may be substantial, these examples are likely to continue. This trait of builders, or anyone else, ignoring professional advice is worrying as it appears to be becoming much more widespread. Retaining walls clearly remain a significant issue that requires vigilance.*

See also the [Structural-Safety data base](#) for:

129 Responsibility for boundary retaining wall

134 Deadly retaining wall

162 Collapse of blockwork retaining wall

#### **LACK OF CONTROL ON SITE WHEN UNDERPINNING (Report 241)**

The concern is in relation to the sequencing of construction and the lack of control on site from competent persons. The reporter says that a Victorian building with four storeys and a basement was being converted to a small hotel. As part of this work the basement level was being lowered by approximately 1m. The construction sequence adopted was to excavate the soil from the inside to the founding level across the whole basement, before underpinning the walls. The footings for the retaining walls were on fill material, as was the backfill, so in the temporary case there was no lateral restraint to the toe of the walls and there was inadequate vertical support under the base of the wall. To make matters worse fill material was being stored close to the basement retaining walls at ground floor level, thus adding a substantial surcharge load. The contractors had to be persuaded to add some temporary propping. A structural engineer was employed to carry out a design but had no remit to inspect the works on site. His design did not take account of the additional retained height of fill against the walls in the permanent condition, nor did it suggest a safe method of construction.

#### **CROSS comments**

*There have been several reports to CROSS of failures during building alteration and some have resulted in total collapse. Alteration of old buildings carries risks of structural movement and failure that are often underestimated by owners, developers and building contractors. This report highlights yet again that critical strength and stability states can easily occur during construction. These are particularly dangerous in exposing construction workers carrying out alterations to severe risk. The report also highlights the dangerous interface in transition to a finished design where no competent party is in charge of stability during construction. Carrying out alterations in basements is complex and often entrusted to builders who may not fully appreciate the dangers. In this case, a proper design risk assessment could at least have highlighted the dangers of sideways footing movement and required a staged process of underpinning and restraint. In a safety-*

## REGISTRATION FOR CROSS NEWSLETTERS

To register for CROSS Newsletters and SCOSS publications go to the website ([www.structural-safety.org](http://www.structural-safety.org)) and on the right hand side of every page there is a 'Register' box. Enter your name and email address and click the 'Register' button. An email will be returned to your address confirming that you are on the list of subscribers.

## FEEDBACK

With the 'Feedback' facility you can send comments on any aspect of CROSS or SCOSS or of the site or on anything to do with structural safety, and also read the input from others. More feedback is wanted.

## REPORTING

Use either the 'How to report' button on the top of the website <http://www.structural-safety.org> or the similarly labelled button on the right hand side to send on-line or off-line reports. It is simple, confidential, and could be important. [Click here](#) to go directly to the reporting page

### HOW TO REPORT

Please visit the web site:

[www.structural-safety.org](http://www.structural-safety.org)

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When reading this Newsletter online [click here](#) to go straight to the reporting page.

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*critical industry that nonetheless permits unlicensed parties to operate, and permits restricted briefs which prevent structural engineers from obtaining a full appreciation of the project, this situation will arise. There is an argument to say that under the IStructE code of conduct, in order to ensure the safety of others, any engaged structural engineer must make enquiries to determine the appropriateness of his contribution to the project as a whole and must pass on sufficient information to the Client or others on any assumptions made e.g. construction sequence. Perhaps engineers should simply refuse to take on such works unless they have the full design and supervision brief. Indeed there are cases of engineers being prosecuted by HSE for site failures. There is a need to encourage clients to engage qualified and competent structural engineers and give them an adequate brief.*

See also [Structural-Safety data base](#) for:

72 Underpinning

123 Shop/domestic building collapsed

128 House collapse

175 Unsuitable underpinning

## CHECKING AT A PRICE (Report 227)

In relation to the checking of calculations on behalf of local authorities for building regulation submissions (CROSS Newsletter No 20 report 210) a reporter is concerned about checking engineers who are paid very low hourly rates. In one case, says the reporter, checking is done by an experienced chartered engineer with reasonable judgment and skills, but with no knowledge, or very limited knowledge, of limit state codes or Eurocodes. This engineer was engaged to check a project that had been designed using finite element methods to Eurocode standards, and the reporter suspects that, in approving the design, this engineer did not check it thoroughly as he had no access to relevant software. What can one do in such circumstances, asks the reporter? It is difficult for designers to go to the local authority and accuse them of not checking properly, as is their duty, and ask them to get their sub-contract engineer to do it more thoroughly.

### CROSS comments

*It is of course the responsibility of the originating design organisation in the first instance to check the design and there should not be reliance on Building Control. Nonetheless, Building Control Bodies, in exercising their responsibilities, need to ensure that they are engaging appropriately experienced and competent engineers. Some authorities may have difficulty in doing this if they lack structural engineering skills themselves. This Newsletter will be seen by many Building Control Bodies and may act as a prompt for them to consider the adequacy of their processes. In this case the combination of FEA and Eurocodes implies that a sophisticated design was involved. The use of FEA can be a problem and what should be done is to look at the magnitude of the forces and perform some simple calculations to see that the scale is right. It is the lack of adequate assumptions on force flow and load distribution that needs the greatest checking. Experience, skill and judgment are the required skills. Sufficient information on input and output should be provided in the design calculations so that another person can produce similar results even if he does not use the same software. Checking one software product against another is difficult even for experts.*

## DATES FOR THE PUBLICATION OF CROSS NEWSLETTERS

Issue No 25

January 2012

Issue No 26

April 2012

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