

# CROSS

## Confidential Reporting on Structural Safety

For an introduction to CROSS see [www.structural-safety.org](http://www.structural-safety.org). Email: [structures@structural-safety.org](mailto:structures@structural-safety.org)

### NEWSLETTER No 33, JANUARY 2014

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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 database.

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#### INTRODUCTION

Since the last Newsletter there have been two major collapses of shopping mall roofs: one which was under construction near Durban killed two, and the other in Latvia which killed fifty four and has resulted in the fall of the government. A major objective of CROSS is to publish concerns which might be precursors to more major failures so that they may be recognised. In the last Newsletter (No 32 October 2013) the first report was "[Partial roof collapse at shopping centre](#)" which described a collapse that occurred at night and fortunately there was nobody underneath. Had it happened during the day it could have been in the same category as Durban and Latvia. The lesson to be learned is that large numbers of people congregate underneath shopping mall roofs and they are safety critical structures deserving close attention during design, construction, and maintenance.

Just before Christmas there was a partial collapse of a ceiling at a theatre in London. Several reports on failures of heavy ceilings can be found on [www.structural-safety.org](http://www.structural-safety.org) by entering "ceiling" into the Quick search box on any page. Our comments on this at the time were: *The danger of falling ceilings is not new; there is old cinematographic legislation that was brought in because of failures with lath and plaster ceiling fixings. The Home Office document 'Recommendations on Safety in Cinemas 1955', and which is still relevant says: "Ceilings shall be in such a condition as not to cause a danger to persons visiting the premises".* Another precursor - and in this Newsletter there is a report about a suspended ceiling failure in an old building due to faulty installation of fixings.

This Newsletter also has reports on other events that have occurred in service including the collapse of a balcony due to mis-placed rebar and a further example of RHS sections splitting when water is trapped and freezes. Several reports which have been received from concerned engineers about the possible consequences of cut price design and about responsibilities are also shown.

The new Structural-Safety web site has been launched and whilst it looks much the same as before there is a new content management system running in the background. This handles published reports, as well as providing a platform for other countries to have their own schemes. The first to join is Southern Africa which encompasses the Republic of South Africa, Angola, Botswana, Lesotho, Mozambique, Swaziland, Zambia, and Zimbabwe. Their Sponsors are the Joint Structural Division, the South African Institution of Civil Engineers and the Institution of Structural Engineers. Details are to be found by going to the International page and a warm welcome is extended to participants in these countries. The site will be further developed in the coming months.

**The success of the CROSS programme depends on receiving reports, and individuals and firms are encouraged to participate by sending concerns in confidence to Structural-Safety. More reports are always needed.**

## 341 BALCONY COLLAPSE AT BLOCK OF FLATS

### 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
- Temporary Works Forum
- UK Bridges Board

A reinforced concrete balcony collapsed at a block of flats which are believed to have been built in 1966. Fortunately no-one was injured. An HSE Construction Specialist Inspector found that the external balcony appeared to be a continuation of the floor slab and served as the residents' only access to their individual flats. It was approximately 150mm thick and cantilevered by approximately 1.3m. A majority of the reinforcement, just over 1/4in or 8mm approximately in diameter, was located in the bottom half of the slab (compression zone) and some of the reinforcement had next to no cover. The closest the reinforcement appeared to get to the tension zone was around the neutral axis. It would seem that the most likely reason for the collapse was the lack of reinforcement in the tension zone. However, the balcony had clearly managed to remain in place for the last 40 years or so, relying only on what little tension capacity was afforded by the unreinforced concrete. HSE have been advised that there are a number of other similar balconies in the area. These have now been propped and work is underway to assess whether they too are susceptible to a similar type of failure. Work is in hand to repair the balconies in a risk based priority order.



Fall of 2<sup>nd</sup> floor balcony onto 1<sup>st</sup> floor (reproduced with permission)



Rebar in the bottom of cantilever slab (reproduced with permission)

### Comments

*It is not known why the bars were in the wrong face although they may have been placed correctly but without adequate support, and site operatives have walked on the bars and displaced them whilst placing concrete. Or perhaps there was a continuous shutter under the slab for the interior of the building and the balcony and no recognition that the last section was a cantilever. The bottom rebar for the interior span was simply carried on into the cantilever. In any event there was poor control on site and for reasons of quality and safety there has to be competent and resourced supervision. Since this case was brought to the attention of HSE there have been reports to them of other cases so the problem may be systemic.*

*Structural safety relies not just on adequate strength but also on controlling modes of failure such that they are ductile, benign and give warning of impending collapse. Rapid brittle failures of any kind are to be feared. No doubt this slab was mostly relying on tensile capacity of the concrete to survive, but even if that had been adequate, the slab would have been 'unsafe'. Great care is also required if percentages of rebar are small such that members have less bending capacity than they would have based on the tensile strength of the concrete. The danger is that under increasing load, the member fails at the higher moment and load transfer to rebar is so rapid it just snaps rendering it useless. The incident once again shows the importance of an experienced person just walking around sites and seeing that gross mistakes are avoided.*

To find reports in the data base go to the **Quick Search** box on any page of the [Structural-Safety](#) site and enter a subject e.g. "wall" and a list of summarised reports will follow. Searches can be refined using **Search data base** facility.

## 304 PARTIAL COLLAPSE OF SUSPENDED CEILING

A section of suspended ceiling in a multi-storey building collapsed and it was fortunate that there were no injuries, says a reporter. The ceiling, which was

## NEWS

The Institution of Structural Engineer's *Manual for the systematic risk assessment of high-risk structures against disproportionate collapse*, authored by David Cormie, is now available to purchase from the Institution website (<http://shop.istructe.org/manual-for-the-systematic-risk-assessment-of-high-risk-structures-against-disproportionate-collapse.html>). Also now available from the same site is *Risk in Structural Engineering* (<http://shop.istructe.org/risk-in-structural-engineering.html>).

much newer than the building, consisted of 1200 x 600mm mineral fibre tiles laid into a grid system supported by 2mm galvanised wires. These were connected to eye bolts which were screwed into expansion anchors drilled into what appeared to be a plaster soffit. In the collapse area some of the expansion anchors had become detached from the soffit. The building was originally constructed using an early reinforced concrete floor system with hollow tiles, possibly clay based, between one way span insitu ribs. The underside was then plastered. Some anchor holes had been drilled into the plaster and the tiles but neither was a suitable substrate material. Other anchor holes were drilled into the concrete ribs but stopped short when reinforcement was hit. Whilst the building was old the ceiling had been in place for between 10 and 15 years. The reporter believes that the ceiling was inherently unstable and liable to failure at any time.



## Comments

*This failure repeats yet again a pattern that has been observed in a significant number of incidents from the Boston Tunnel (USA) and the Japanese Sasago tunnel lining to various heavy ceiling collapses reported to CROSS. There are two issues. Firstly the potential for an anchor coming out for a number of reasons (a common one is putting them in too short). Secondly, and more widely, the possibility that any single failure will initiate a cascade type collapse. BS EN 13964-2004 is now the definitive standard for the manufacture and installation of suspended ceiling systems and applies in all countries of the EU. It contains advice on selecting fixings appropriate to different substrates and should be used for new installations. BS 8539:2012 Code of practice for the selection and installation of post-installed anchors in concrete and masonry is the standard to use for fixings and guidance is also given in "Selection and installation of top fixings for suspended ceilings" published by Association of Interior Specialists and the Construction Fixings Association in 2012. Predicting whether an existing ceiling is safe is difficult but if there is any doubt then the fixings should be examined. SCOSS will be issuing an Alert on Tension Systems in the near future.*

## 314 MORE ON FREEZING AND GALVANISED HOLLOW SECTIONS

In CROSS Newsletter 26 there was an article (report 253) on *Freezing splits galvanised steel columns*. A reporter says that in the course of his work for a Warranty provider he was involved in correcting a cold formed galvanised SHS (120 X 120 X 5) 4 storey balcony structure which had longitudinal splits formed in at least two of 4 columns that supported these balconies. The issue was that SHS balcony support posts filled with water and then split on a cold night. This echoes very well the issue reported in 253. Sections of the SHS were assessed by an expert who indicated that some SHS, CHS and RHS members are susceptible to splitting under freezing water conditions dependent on thickness of tube and shape. Water entered the tubes through what appeared to be poorly designed or detailed spigot and socket joints which were not adequately sealed. The steelwork designers / fabricators / erectors and Contractor's staff had not realised the hazard and possibility of it causing a failure. The reporter and other Engineers involved had not seen the phenomenon before and initially there was unjustified concern over steel quality. The four columns were replaced and care was given to sealing the tubes to prevent water ingress in the future.



Water released from a stanchion  
(reproduced with permission)



Longitudinal split (reproduced with permission)

### Comments

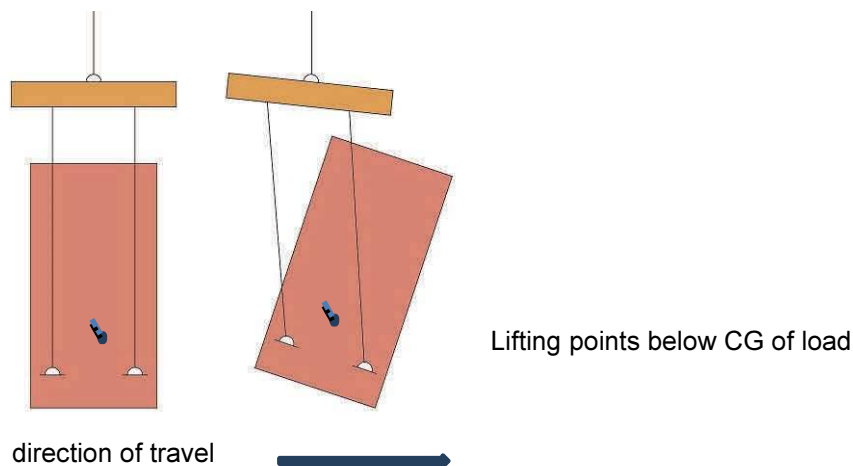
*It is an eternal truth that water will get in anywhere and one solution is that it should be permitted to drain away. There have also been instances of similar problems on fairly small section motorway gantry legs where small holes and unsealed joints can lead to a differential pressure sucking moisture into the internal voids in steelwork. This was then frozen and thawed leading eventually to splitting. A positive venting system (a modest sized hole) low down has been successful in avoided this happening again. A paper entitled "Internal resistance to corrosion in steel hollow sections" by Michel Tourney, 2002, gives information about moisture in tubes with a number of examples of corrosion over time. Similar issues have been reported previously:*

*CROSS report [253 Freezing splits galvanised RHS columns](#)*

*SCOSS report [5002 Stadia crash barriers](#)*

## 320 LIFTING AN UNBALANCED LOAD

This relates to the lifting of an item of plant by a tower crane during which the load toppled from the slings causing considerable damage and delay. By chance serious injury was avoided. A lifting frame was positioned above the load with chains at each corner which were connected to the bottom of the load. The centre of gravity was above the base of the item of equipment and, as it was lifted, the item swayed sideways and fell through the chains until it was almost upside down. Whilst the capacity of the crane, the lifting frame, and the chains were entirely adequate for the load, the arrangement whereby the chains were attached below the centre of gravity of the item of plant was flawed. The point of application of the lift should have been above the centre of gravity of the item being lifted.



### Comments

*A fundamental point is that the depicted lifting system is actually a mechanism. If the test of applying a horizontal load had been applied, and consideration given to displacement it would have been seen that the system was unstable. In all issues of robustness, if there is no obvious horizontal load (like wind) a notional load related to self-weight should be used and this will act through the centre of mass. As the reporter says, this system is then unstable. With temporary works a minimum horizontal load of 2.5% is used (BS5975). However designers might want to consider a higher load in the case of handling due to greater uncertainty of acceleration-induced loads (jerking), and probable uncertainty of the exact location of the centre of gravity.*

## 312 LOOK-ALIKE CONSTRUCTION EQUIPMENT

A reporter wonders if the risks brought to the industry by look-alike temporary works equipment is something that had been reported to CROSS? If not he asks whether others share his concern.

### Comments

*With global resourcing this is recognised as a problem. As with certification generally it requires vigilance. The views of readers will be welcome.*

## 365 ALTERATIONS TO EXISTING BUILDINGS WITH NO SITE VISITS

Another reporter is involved with structural alterations and extensions to existing domestic buildings and smaller commercial type buildings (and others). Structural engineers are doing the structural calculations and drawings based on the Architects' drawings only, with no site visits.

- If the Architects drawings do not show any floor, wall or roof construction or even floor spans, roof spans etc. how is this being done?
- How can you alter a three storey building when you may not even have the first or second floor plans?
- How do you even know if the architect's drawings are correct (many first floor wall positions are slightly off centre relative to the ground floor walls etc.)?
- How can a project receive building regulation approval if the engineer has never even seen the property?

The reporter blames fee competition and the potential reduction in fees to the client if site visits are avoided.

### Comments

*It is of course wrong for engineers, or anyone involved in refurbishment, not to properly check or investigate the actual condition of a building before work starts. Those involved are leaving themselves open to serious action should there be a problem. Even if drawings exist they need to be treated with caution. Alterations are made over the years which may not be recorded and deterioration may have occurred. Making alterations without proper information or verification is potentially dangerous. Reckless fee competition to the degree where sound engineering and construction is compromised may lead to consequences that affect public safety. This example is similar to Report 411 Quick & Cheap Design Calculations.*

## 361 BASEMENT PARTY WALLS

The client's Consulting Engineer had designed a new basement but, when queried by the Consulting Engineer for the main contractor, was unable to provide survey information for the adjoining property and made it very clear he didn't consider it necessary to know what was on the other side of the party wall. The adjoining owner's Party Wall surveyor's engineer told the reporter that he was well aware that this is a common occurrence. The reporter understands that other Consulting Engineers have found the same situation. He considers that there are two risks:

- Temporary works failing (including excavation with stanchion/wall falling in)
- Permanent works failure.

### Comments

*The reporter is correct. The Designer of any basement ought to consider all possible loads which includes surcharge from adjoining properties. It is also essential to know the condition and stability of adjoining structures to make sure that the methodology of basement installation does not endanger the stability of adjoining property. Any one carrying out such work without checking on the state of the adjoining property is also running a serious commercial risk of legal liability in the event of damage due to the new works. If the property had not even been surveyed what defence would there be? If the Designer were a member of a professional Institution such inaction would contravene their code of conduct.*

## 411 QUICK & CHEAP DESIGN CALCULATIONS

A building control officer says that he recently received a set of calculations which had been prepared through a website that specialises in providing calculations at a very low price. They do this by having a number of generic designs which are then adapted to the purpose. The project was a small commercial premises that had put in a mezzanine without approval or correct design and calculations were submitted after the fact without justification. The concern is that the calculations were done without the engineer ever visiting site or even clarifying site conditions to the point where they are assuming the existence of a supporting beam, the size of the existing beams, and the existing loading conditions among other things. The calculations themselves were only checks to the beams but were presented as structural calculations for the mezzanine floor. They were only produced after concerns were raised by the Local Authority, and in fact the structure was erected with no on site calculations having been produced. The 'cheap' calculations were of no value. The reporter feels that this could set a dangerous precedent where calculations are done on the cheap and as an afterthought rather than being an integral part of the design process.

### Comments

*Reports like this occur far too often. The fundamental issue is that some people think 'design' is just producing a set of calculations by some means when actually such calculations are totally meaningless without proper attention to actual conditions and detailing. It's just irresponsible and even worse when it is done by a qualified engineer. This report shows the value of effective building control. In 1999 SCOSS warned of the risks in using computer aided calculations and there have been reports of concerns about the subject since CROSS scheme started in 2005. Anyone can present a building control submission and some small-scale builders find this arrangement attractive.*

## 348 RESPONSIBILITIES OF LOCAL AUTHORITIES FOR POSSIBLY DANGEROUS STRUCTURES

A reporter, who used to be involved with building control, believes that Local Authorities have a duty to decide if a danger exists when a member of the public draws their attention to a potentially dangerous situation. The public should not be expected to be experts in assessing if a structure is dangerous or deciding what should be done, however the reporter is unsure to what extent LAs have legal powers/duties to address any danger. For example, do such powers/duties extend to free standing or retaining walls? The reporter also recalls a situation when a very experienced chartered structural engineer who observed the construction of the frame of a building and was convinced, together with some fellow engineers, that it was unsatisfactory. He contacted building control and was told that the project had been checked by an approved inspector so the LA was satisfied that all was OK. This did not satisfy the concerned engineer but what else could he do? The reporter acknowledges that this is a complex subject but wants more informative guidance to be made in, say, The Structural Engineer.

### Comments

*Local Authorities have a duty in relation to dangerous structures (either under the Building Act 1984 or London Building Acts (Amendment) Act 1939). This applies to 'a building or structure, or part of building or structure' and so retaining walls and the like should also be covered. Sometimes these structures are also covered by other legislation, such as that for highways or railways. Dangerous structures legislation does not apply to the control of building work, unless the work is imminently dangerous and affects the general public, such as being over a public highway. Whether a building is unsatisfactory or not is a matter for the building control body and in this instance the Approved Inspector was responsible. Dangerous conditions wholly within the construction site are controlled by HSE, and the reporter could have referred the matter to them. Papers on the subject have been published in The Structural Engineer:*

- *Questioning the responsibilities of an engineer, Bill Harvey, January 2007*
- *Dangerous structures and buildings, Martin Ashmead, March 2009.*

*A related question is whether a chartered engineer has an obligation or duty to act if he/she sees something that is, in their opinion, manifestly unsafe? The answer will depend upon legal circumstances, Institution codes of conduct, and ethical considerations. Views on this too will be welcome.*

### 346 VIADUCT SURVEY CONCERNS

A small four span brickwork railway viaduct has been degrading for some time and a reporter, who was not associated with the structure, noted that cracks had worsened over recent years. The reporter believed that previous strengthening measures had done no good and may indeed have done harm. He proposed to the authorities that they should carry out an urgent investigation. This was done and after reviewing documentation and making an initial visual inspection a number of concerns were identified, although it was considered that the structure was coping with the loads imposed upon it. A detailed examination of the underside of all four spans was then made with a view to carrying out a full structural assessment and initiating a programme of remedial works.

#### Comments

*This is a good example of a conscientious engineer observing a deteriorating situation and bringing it to the attention of the relevant authorities who then responded positively and took action. The situation is similar to that considered in report 348 above. This form of structure is very sustainable when well maintained, but it should be noted that without a proper knowledge and conceptual understanding of the behavior of masonry arch structures some forms of strengthening can be damaging and dangerous. Expert advice should be sought. CIRIA gives guidance in their document: "Masonry arch bridges: condition appraisal and remedial treatment, McKibbins, L; Melbourne, C; Sawar, N; Sicilia Gaillard, C CIRIA C656 © CIRIA 2006 RP692"*

### 358 COLLAPSE OF OFFSHORE MET MAST

The top two thirds of a three part off-shore lattice mast failed due to problems with some of the connection bolts. Initially it was not clear whether the bolts failed or came undone. At failure the resulting momentum of the falling section caused further damage to the remainder of the structure. The mast had been regularly inspected. Although it was not confirmed as a cause of failure, it is believed by the reporter that the base had been designed for wave loading and the lattice tower had been designed for wind loading. The effect of wave loading on the dynamic response of the lattice tower, says the reporter, may not have been considered.

#### Comments

*Care is required to ensure that components procured from different suppliers are not designed in isolation. The laws of physics will not respect contractual boundaries and so the assembled structure must be considered as an integrated design.*

*Whilst CROSS has taken every care in compiling this Newsletter, it does not constitute commercial or professional advice. Readers should seek appropriate professional advice before acting (or not acting) in reliance on any information contained in or accessed through this Newsletter. So far as permissible by law, CROSS does not accept any liability to any person relating to the use of any such information.*

#### HOW TO REPORT

Please visit the web site  
[www.structural-safety.org](http://www.structural-safety.org)  
for more information.

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

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#### DATES FOR PUBLICATION OF CROSS NEWSLETTERS

Issue No 34	April 2014
Issue No 35	July 2014
Issue No 36	October 2014
Issue No 37	January 2015