CROSS

Confidential Reporting on Structural Safety

Newsletter No 14, April 2009

Reports in this Issue

Please **click here** for link to CROSS website

INTRODUCTION

There is encouraging support from the infrastructure and public sectors for the work of CROSS. Following meetings with SCOSS and CROSS, the Highways Agency have agreed to back the scheme and recommend it to their suppliers. The Highways Agency is an Executive Agency of the Department for Transport (DfT), and is responsible for operating, maintaining and improving the strategic road network in England on behalf of the Secretary of State for Transport. This includes managing traffic, tackling congestion, informing road users, improving safety, minimising adverse impact on the environment and more. Their suppliers include consulting engineers, construction companies, and materials providers.

LABC is the member organisation representing local authority building control departments in England and Wales. It promotes the design and construction of safe, accessible, environmentally efficient buildings that comply with the Building Regulations and now also supports CROSS. The Scottish Building Standards Division has supported the programme since the SCOTCROSS scheme in 2007. It is anticipated that liaison with, and the support of, these major bodies will lead to more reports about roads and bridges, and more reports about building control issues, thus widening the network of those who can benefit from the lessons learned by others.

In this issue is an important report about public art works on or near highways and the need, in some cases, for appropriate engineering input to the design and construction of large sculptures. There is also the summary of a report about the slippage of a bridge being erected over railway published with the permission of Transport for London together with reports about similar incidents from the past.

Of course to make the programme as effective as possible reports are needed on a continuous basis so if you have a concern, or know of an incident that involves structural safety, that could be passed on then please contribute. Details of how to do so are on the CROSS website as are all of the Newsletters.

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PUBLIC ART STRUCTURES

A report has been received from two engineers who have noticed a trend for more works of “Public Art” being placed near to highways and in cities. The works may be large and warrant a significant engineering input but may be driven forward by persons without sufficient appreciation of the technical issues involved. On occasions due to the, often complicated, contracts and agreements that are in place – especially on larger regeneration projects – the procurers of the art have no contact with those who will be responsible for its long term inspection and maintenance. By their very nature public art tends to be one off and may, for example, be conceived and created by – say a sculptor. For public art structures the familiar codes and standards for highway situations from the *Design Manual for Roads and Bridges* may not be directly applicable. The reporters give several examples including three that are particularly relevant.

Example 1 is of a spectacular lighting scheme with unusually shaped steel columns that was developed for a square in a city centre. It was felt necessary by the reporters to have a structural engineer modify the proposals to improve basic stability and to facilitate fabrication of the complicated shapes, and to redesign the foundations. The lighting has been in use for a few years and there are issues as to the long term maintenance - for example changing the lamp or the special casings. Vibration is a significant consideration as it is unpredictable how such features will oscillate under wind loading and the magnitudes of the deflections.

NEWS ITEM

Cologne collapse

There has been much in the technical press about the collapse at the beginning of March of the archive building in Cologne. The ground underneath the building appears to have collapsed into an excavation for a new cut and cover tunnel for light railways. Photographs show masonry debris which may be from the structure of the building or may be from facades and internal walls. There is speculation that the ground collapse is associated with water ingress and the failure of a 28m deep diaphragm wall. Media reports from Germany say that construction managers and city officials saw measurements that showed the archive was sinking into the excavation work below it weeks before the building collapsed. Accident investigators will be reporting on the reasons in due course but meantime there will be concern about similar schemes.

***CROSS Comments**: CROSS has had reports about sudden failures associated with undermining (reports 123 and 128 Newsletter No 8 January 2009) and about the importance of ground anchors (report 087 Newsletter No 8, October 2007) but not on the scale of the Cologne collapse. However in risk analysis the significance of pre-curser events is important, and consideration of concerns on a lower scale can help to identify the possibility of events on a much higher scale. This is part of a pyramid of risk. If sufficient examples of pre-cursor events are sent to CROSS and published, and if they are seen by designers and constructors, then other episodes, with possibly severe and tragic occurrences may be prevented.*

Example 2 is a sculpture of a larger than life size animal in a busy city centre street. The original design did not have a structural frame, and by virtue of its shape would have been unstable. Engineers from the reporters' organisation had to design an internal space frame and devise unobtrusive ways of tying down the sculpture to resist loads, including those from persons who might want to climb on the animal. The reporters believe that designers of art works may fail to foresee how their creation may be misused by some members of the public.

Example 3 was a tall landmark feature adjacent to a major road and was intended to sway in the wind. Unfortunately the amplitudes were so large that, even at relatively low wind velocities, the authorities were worried about motorists being distracted and there were structural safety concerns. The feature had to be dismantled. Aerodynamic modelling was then carried out and significant modifications were made to the structure before re-erection in a different location.

Reporters' conclusions:

- Engineers should be more proactive in using their authority and expertise in explaining to others the necessity for appropriate technical input. Cantilevers and complex or slender shapes with unusual load paths may lead to dynamic problems and vibration and fatigue. Also, in general these types of structure will be much more difficult to erect, the part erected components becoming stable only in the completed situation. Meaningful dialogue is required between Designer and Erector.
- Planning authorities *(as well as other local authority departments)* need to be more aware of the potential pitfalls when issuing permissions for works of art on and adjacent to the public highway. Prior to a project proceeding too far a complete risk assessment needs to be carried out, covering not only hard technical matters but softer issues such as public reaction to an unusual object. At this stage the basic concepts may need to be amended. An *Approval in Principle* should then be agreed between the Designer and the approving authority, making clear which standards of design and control apply.
- Proper inspection regimes need to be set up and funded. Where the design is non standard it is vital that the maintaining organisation understands how to do its work and procure any necessary spare parts. In this respect an up to date and accurate *Health & Safety File* can greatly assist. In practice it is often the experience of the reporters that those who would most benefit from seeing the *Health & Safety file* do not have ready access to it! Funds may not have been allocated for the File's upkeep or storage due to a lack of recognition of its importance by decision makers.
- Durability and fixing details are often overlooked and need to be carefully thought through at design stage. There should not be features that are difficult to uncover and inspect. Corrosion protection and behaviour in the event of vehicle impact and fatigue are difficult to predict in these one off structures. Assumptions as to design life and frequency of inspection and maintenance need to be discussed and agreed in advance between the Designer and Adopting Authority.

***CROSS comments**: There are of course numerous successful and well loved large public works of art, many of which have been on display for a great number of years. Some are not on the highway but on private land where there are no controls, and even on the highway the Highways Authority would not necessarily have the expertise to check on structural stability. Planning Authorities generally have no control over the structures for works of art and the Building Regulations do not apply. In practice there may not be any secondary checking and a local authority may only take action when it becomes aware that the work is a potentially dangerous structure. Structural engineers add value when consulted in connection with such works because, in addition to considering the structures, they have an overall knowledge of the design and procurement process.*

Notwithstanding the inapplicability of highway or building standards, those involved have obligations under the Health and Safety at Work Act to have regard to the safety of those who may be affected. This was visibly demonstrated by the recent conviction of the artist, the events management company and the local authority in respect of the deaths resulting from the failure of the Dreamscape inflatable sculpture at Chester le Street in 2006.

A giant white horse has been chosen as a new £2m art commission for south east England dubbed "Angel of the South". The horse standing on all four hooves will be about 50m (164ft). From Los Angeles it is reported that there is to be another 50m tall work comprising a crane with a steam locomotive suspended from it at a cost of $25m.These will require major structural engineering input and the reporters are to be thanked for their advice to those involved in such monumental works. (Report 136)

UNSAFE STREET LIGHTING COLUMNS

improperly installed and damaged base

An overseas reporter says that majority of street light poles and advertisement board bases in his location are not constructed to the proper standard of safe practice for structural engineering and this creates a potential source of accidents. Errors include inadequate minimum edge distance between concrete face and bolt centres, no grout between base plate and foundations, and no protection to the bolts and base plates. The reporter believes these could affect the safety of road users.

***CROSS comments**: Design and construction standards for new street lighting columns have been in use for several years, but older structures still exist and it is probably these which are the subject of UK press reports. In one town more than 500 lamp-posts were deemed to be unsafe and a survey of lamp-posts in another found that they were suffering "structural failure", where more than half have been eroded by rain and dogs. SCOSS drew attention to the problems of aging lighting columns in section 3.6 of their Report 12 in 1999. Ten percent of the 6.5m lighting columns in the UK were estimated to be in urgent need of repair or replacement. Steel columns can suffer from fatigue due to wind oscillation, and by the seaside even galvanised post have a very finite life. Corroded lamp posts in particular pose a big risk if they are hit by a vehicle and potentially unsafe columns should be reported to local authority Highways Departments.* (Reports 098 and 114)

SCHOOL FASCIA BOARD FAILURE

the fallen fascia

end grain of rafters

inadequate nailing

A section of pressed steel gutter and plywood fascia board at a school collapsed during or after a heavy rainstorm. The reporter believes that it had been in service for 15 to 20 years. He understands that staff and pupils had walked beneath the failed gutter just minutes before its collapse, narrowly avoiding a serious accident. The gutter was about 200 mm wide x 250 mm deep. He believes that the down pipe may have become blocked, allowing the gutter to fill during heavy rain. The method of fixing the gutter and plywood fascia board was simply by nailing into the end grain of the rafters, which are at 600 mm centres. Inspection by the reporter revealed that there was no other support. BS 5268 cl 6.4.4.3 states that 'no withdrawal load should be carried by a nail driven into the end grain of timber'. He therefore regards this fixing detail as inadequate and potentially dangerous and is concerned that the detail might have been used on other institutional buildings.

***CROSS comments**: CROSS has previously had reports concerning failures at schools including a brickwork cladding panel collapse (Report No 078 Newsletter No 8, October 2007), and the collapse of internal wall due to wind load during construction (Report No 099 Newsletter No 10, April 2008). This is another example of a collapse that could have had tragic consequences and the question might be raised as to whether the standards at schools differ from those in other buildings. Apparently trivial details may not receive proper engineering attention but are nevertheless vital. All building work needs to be 'robust'.* (Report 137)

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
- Communities and Local Government
- Construction Industry Council
- Department of the Environment
- Health & Safety Executive
- Highways Agency
- Institution of Civil Engineers
- Institution of Structural Engineers
- Local Authority Building Control
- Scottish Building Standards Agency

TEMPORARY BRIDGE JACKING

Transport for London (London Rail) reported publically on an incident concerning temporary bridge jacking and permission to reproduce an extract is gratefully acknowledged by CROSS. In early May 2008 Bridge GE19 was successfully moved into position above Network Rail tracks just outside Liverpool Street station, and a few weeks later the bridge was in the process of being 'jacked down' into its final resting place. After work had finished for the day the temporary supports for the bridge failed at the east end. This failure resulted in the bridge dropping approximately 200mm off the temporary support plates onto the permanent bearings. Five concrete planks on the bridge deck were dislodged by this movement and fell onto the Network Rail tracks below. An approaching train struck the concrete planks at slow speed.

Following the incident TfL set up an Inquiry into the incident. This Inquiry Panel has concluded that the key contributory cause of this incident related to the incorrect positioning of slipper pads (metal plates covered in Polytetrafluoroethylene (PTFE)) between the base of the bridge and the top of the sloping surface of a set of taper plates, which themselves had been placed on the top of the temporary support arrangement. This incorrect positioning allowed an unplanned movement to occur. The PTFE pads provide a low friction surface, and were being used to make small adjustments to the horizontal positioning of the bridge. There are a number of contributory factors that are associated with this incident, and these are also discussed in detail later in the report which is on www.tfl.gov.uk/assets/downloads/GE19-Incident-Main-Report.pdf .

A CROSS reporter praises the open and prompt release of the TfL report and adds similar experiences of his own.

1. Some years ago I witnessed the aftermath of the failure of a bridge that was under construction – a braced-pair of welded plate girders had been erected on piers and the deck slab was being cast sequentially at one abutment and jacked along the girders with (I believe) graphite at the girder top flange/deck slab interface. There was a longitudinal fall on the bridge, the casting abutment being at the high end of the bridge. The deck slab just carried on sliding along the girders and, as it gained momentum it slide sideways, precipitating instability and collapse of the girders and deck slab.

2. About the same time I was working on a 1km viaduct with three 150m balanced-cantilever sections over a river. This used two travelling gantries to sequentially cast each pair of cantilever sections. The gantry falsework was supported on PTFE bearings running on steel beams and moved forwards by means of hydraulic rams but, as far as I recollect, with no means of preventing the gantry travelling forwards of its own volition - there was a very small longitudinal fall on the bridge.

The reporter believes that there should be advice available on the more general subject of temporary works involving low friction bearings. In particular it seems to him to be essential to highlight the need for vertical supports involving parts undergoing relative horizontal translation to have articulation surfaces that are horizontal as a norm or, where this is not possible (usually an exception), provision is made for any resulting non-vertical reactions/displacements. Additionally, in his view, even where surfaces are horizontal, there should be provision to allow for tolerances in such surfaces that could give rise to uncontrolled responses.

***CROSS comments**: This report illustrates the benefits that might have been achieved if the reporter's experiences had been more widely publicised at the time. The important lesson is that any structure which has a sliding mechanism should have the means to control and stop the movement. In 1999 four men died when the maintenance gantry on which they were working on the M5 Avonmouth Bridge was caught by a gust of wind and blown along the beams from which it was suspended. The trolleys holding the gantry dislodged temporary beam clamps which were meant to prevent them moving and fell through a gap where a beam had been removed but not replaced. The contractors involved were fined £500,000 for breaching the 1974 Health & Safety at Work Act and ordered to pay £525,000 costs.* (Report 142)

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If you are already a registered user, enter your username and password, and click the 'login' button. When logged in click on the 'Update Details' on the right hand bar of the website. Click on 'Profile' and put a tick on the SCOSS/CROSS Newsletters box. You will then receive the Newsletters every quarter.

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Post reports to:

PO Box 174
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Comment on the scheme, or non-confidential reports, can be sent to dir.cross@btinternet.com

BRICK BRIDGE COLLAPSE

An historic bridge collapsed minutes after workers fled to safety. They had been reinforcing the flood weakened foundations of the bridge when a crack was seen then two of the three spans of the brick arch bridge fell. It had been closed to traffic for repairs to scoured foundations and engineers apparently said that prior to the collapse there had been no signs of any structural damage, and no indication it would give way. Investigations are being carried out into the cause of the collapse and the bridge will be rebuilt. Whilst no-one could have forecasted how soon collapse could occur, says the reporter, it does beg the question that if the scour was deep/wide enough, perhaps horizontal props should have been installed as soon as possible after the Bridge Inspection that picked it up.

***CROSS comments**: By far the most common cause of bridge failure worldwide is scour, and this is an example. The age of the bridge is significant because older bridges are more likely to have foundations of inadequate depth. The fact that it was a masonry arch may not have contributed to the cause of failure. In general river bridges need adequately maintained river training works, and regular reassessments of the future magnitudes of hydraulic flows, and the adequacy of the training works to contain them. Those repairing damaged structures need to pay special attention to the process of how it is done. In many case preliminary works may be required to prevent further damage and or make the structure safe so that the repair work can start.* (Report 138)

INADEQUATE CHIMNEY SUPPORT

During the refurbishment of an Edwardian single family dwelling a reporter found that the supporting chimney breasts had been removed and replaced with inadequate gallows brackets in the roof space above eaves level. The substantial 2.5m high chimney stack was left almost unsupported and in a potentially dangerous state.

unsupported chimney

roof space with chimney breast removed

***CROSS comments**: Many building control officers will be familiar with cases such as this where the structural significance of a masonry component has been ignored and there is a risk of consequential collapse. Deterioration of the exposed mortar over time, high wind loads, or even a very minor seismic shock could topple the chimney and deposit several tonnes of debris into the house. This illustrates the need for competence and supports the view that any structural alteration works should be assessed by a structural engineer.* (Report 131)

DATES FOR THE PUBLICATION OF CROSS NEWSLETTERS

Issue No 15	**July 2009**
Issue No 16	**October 2009**
Issue No 17	**January 2010**
Issue No 18	**April 2010**