CROSS
Confidential Reporting on Structural Safety

Newsletter No 18, April 2010

Reports in this Issue

Please click here for link to CROSS website

CROSS Contacts

CROSS Director

Alastair Soane

Tel 07836 664 595

Email dir.cross@btinternet.com

SCOSS Secretary

John Carpenter

Tel 07813 853 405

Email jzcarpenter@aol.com

CROSS Web site

www.cross-structural-safety.org

INTRODUCTION

On 1st of April 2010 the Eurocodes for structural design were introduced and whilst there is a great deal of information and guidance available on their use, concern has been expressed that there could be risks during the introductory period. Any reports on issues arising with the implementation of the Eurocodes should be sent to CROSS so that lessons learned can be passed on.

The extended winter, particularly in the northern parts of the country, has resulted in a significant number of collapses due to snow loading with reports of snow depths being greater than those normally recommended for design. CROSS has received some data but would welcome more, particularly from Local Authorities who have had failures in their areas. Reports will be published in a future Newsletter and the information passed on to Regulators and those involved with standards.

The Bridge Owners Forum has become involved with the programme and has passed on for publication a data base of major bridge collapses. It has nearly 400 entries, mostly from the 19th and 20th centuries, gathered from around the world and includes information on location, reason for failure, consequence in terms of lives lost, and a brief description of the event, and can be accessed on the CROSS web site (Bridge Collapses).

To make the SCOSS and CROSS programmes 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, then please contribute. Details of how to do so are on the CROSS website as are all of the Newsletters. In addition to the confidential reporting facility there is a Feedback section which provides a forum for any subject related to structural safety and those with issues to air are encouraged to use it.

COLLAPSE OF LARGE PANEL STRUCTURE BUILDINGS DURING DEMOLITION (Report 186)

In 2009 a Local Authority group was engaged in a scheme for the demolition of two thirteen storey large panel structure (LPS) tower blocks which had been manufactured by a company, now out of business, in the 1960s. The report that follows was sent by a senior member of the group.

A high reach demolition rig with a concrete nibbling attachment was used to reduce a corner of the first building to ground level. The same method was used for five storeys of the opposite corner, but then the wall panels and floor slabs forming the bottom eight floors collapsed progressively and unexpectedly. After precautionary measures were taken, work recommenced to remove the damaged portion of the structure which was now considered to be unsafe. However this also suffered progressive collapse after the removal of panels from the top. The method of demolition was then reviewed and a new system was adopted of reducing four storeys at a time across the rest of the block working around the building in a circular pattern. This was successful.

A consultant with considerable experience in LPS buildings worked with the Local Authority's in-house buildings' investigations team to analyse the second block. However, evidence gathered in the early stages led to such concern that the investigation was abandoned on safety grounds. The group then worked with their contractors and the

NEWS ITEM

Dreamspace fatal collapse

Measuring 50m x 50m x 5m high, the size of half a football pitch, the structure was a series of inflatable cells made of very thin translucent pvc which, where glued together formed the support columns. Up to 100 adults and 25 children could walk through these ovoid cells to experience changes of light, shape and colour, with the whole scenario being enhanced by sound tracks of mood music. The structure was inflated by small fans so that it was supported by air under pressure, and secured by ropes passing around a number of perimeter pods and down through the column, where it was attached to a peg, driven into the ground.

On July 21st 2006 the structure was positioned and inflated by a team under the direct supervision of the designer who instructed them to anchor it with ropes and pegs, although no specification for the peg positions was given to the team. Shortly after it opened on 23rd July 2006, an employee noticed that the wind was passing under the floor and he commenced an evacuation. This was stopped by the designer who sent the customers back into the structure.

He then instructed staff to add additional ropes and anchors, and to possibly reposition some of the existing ties, to the front and along one side of the structure. Many of the ropes were weakened by knots and the methods used to secure the pods. Later that afternoon a gust of wind from the rear corner caused the structure to break free from the moorings and rise into the air.

The flight of the structure was stopped only by it colliding with a CCTV pole and deflating. Had this not happened with the direction of travel it is very likely the structure would have gone into a nearby river. As a result of the incident, two women were killed and 27 other persons were seriously injured.

As a consequence, in September 2006 HSE, via the National Association for Leisure Industry Certification (NAFLIC), issued a Technical Bulletin. (*NAFLIC run a reporting system like CROSS and circulate Technical Advisory Bulletins in response to incidents.*) The police and the HSE conducted an enquiry under the Work Related Death Protocol (WRDP) and prosecutions ensued for manslaughter and offences under the Health and Safety at Work Act. The designer was found guilty of an offence under S3 (2) of the HSWA 1974. The jury could not agree on 2 charges of gross negligence manslaughter, and the CPS decided against a retrial. The designer was fined £10,000, later reduced to £2,500 on appeal. The company which manufactured the structure was found guilty of an offence under S2 (1) of the HASWA 1974 and fined £4,000. The local authority pleaded guilty to a charge under S3 (1) of the HASWA and was fined £20,000.

The installation pre-collapse

client to determine a methodology and control measures for the demolition of the second block in early 2010. After taking down three or four storeys in one corner there was an uncontrolled collapse affecting the complete corner bay over its remaining height. Of considerable concern was the very clean shear failure across the slab/cross wall panel junction indicating a significant lack of connection (mechanical tying) between floor panels and the cross walls forming the structural cells. At the time of the initial collapse the engineers focused on the method and quality of erection.

However this second collapse, and the nature of the failure experienced on both occasions, led to concerns about the integrity of the system as a whole.

Photographs of the collapse of the second LPS block

A short time afterwards the reporter sent CROSS an update on the collapse of a third identical block. Since the second collapse safety measures had included bolting angle connectors between the floor to wall connections across two bays of the structure closest to the neighbouring houses. Demolition began at the end of the structure which had been reinforced, and this bay was successfully reduced to ground level. The rig then started on the adjoining unreinforced area at which point nine floors collapsed. On another section of the block there was a further collapse affecting eight storeys. As can be seen from the photographs the collapses have left almost clean shear planes at the wall panel/floor slab connections. There was more evidence here than was present in the previous cases of a lack of continuity between panels. These identically constructed blocks (pre Ronan Point) had been built by the same direct labour organisation at around the same date.

Photographs of the collapse of the third LPS block

The reporter says that anyone considering the demolition of this type of structure should take measures to determine their ability to resist demolition forces, and ensure that the safety of those involved, or potentially affected, is protected.

NEWS ITEM

Dreamspace fatal collapse (continued)

Impression of the interior experience

Lessons to be learned

- Any structure like this ought to fall under the auspices of HSE Report, HSG 175 Fairgrounds and amusement rides: guidance on safe practice which requires an independent assessment of the device's design including a consideration of all aspects of safety affecting the persons using the device.
- There are relevant standards for structures like Dreamspace and these should be followed. Where there are no apparent standards, a competent person will have to work from first principles. HSG175 requires a full risk assessment to determine all potential hazards that might affect persons using the device.
- Design documentations, including calculations to support the design are required to be submitted to the assessor along with a Risk Assessment
- Safe operating parameters must be specified, together with safe operating procedures including the need for weather forecasts and critical wind speed given in the Risk Assessment.
- Training of staff and emergency procedures must also be well documented - another requirement of HSG 175.
- A Third party review of complex or high risk structures is recommended. Any 'Ride' used in the UK must be independently certified for use by a registered inspection body.
- The LA or SAG should ensure that the documentation is appropriate with relevant calculations and that on inspection, all documented control measures are in place.

Although this relates to a unique form of art, it was in fact a significant structure and required to be properly engineered and certified as safe by a registered body. SCOSS has produced a guidance paper on large outdoor TV screens (http://www.scoss.org.uk/publications.asp) and much of the generality of that paper applies to other structural forms. Readers may also be interested in the article by Pam Waldren (HSE) in the Occupational Safety and Health Journal (July 2009) and in the letter commenting on this in the September 2009 edition.

Permission to publish this article has been given by the Football Licensing Authority and the Emergency Planning College.

YouTube video of failure:
http://www.youtube.com/watch?v=D-GxXBF56qc&NR=1

CROSS comments: *There are two issues here: firstly the demonstration of the lack of robustness in these particular structures when exposed to demolition loading, and secondly the nature of the demolition process adopted. It certainly shows that the forces involved during demolition should nowadays be taken into account by designers, and CROSS has had previous reports of failure during demolition (which can be found on the web site data base).There is always the legal need for a good management system to avoid excessive collapse which could introduce unnecessary risks to operatives, to people who may be nearby, and to surrounding buildings. Learning from this example, the system of work for demolishing similar LPS structures should take into account that sudden progressive collapse may occur. The reporter can be contacted, through CROSS, by anyone proposing to demolish such structures.*

The pictures are very reminiscent of the Ronan Point collapse in 1968 which was the subject of a Public Enquiry in 1968 and Guidelines on strengthening similar LPS tower blocks were later published by BRE. Much was subsequently written about the event and an example can be found on:

http://matdl.org/failurecases/Building%20Cases/Ronan%20Point.htm. The lack of adequate ties between walls and floors and between adjacent floor panels shown in the photographs here means that the buildings would not comply with current Building Regulation A3, but at the time of construction the need for horizontal and vertical tying through mechanical anchorages, or other suitable measures, was not appreciated. SCOSS, along with others, will be further reviewing robustness in large buildings

LARGE PANEL STRUCTURE TOWER BLOCKS AND FIRE RISK (Report 160)

A reporter's firm has refurbished a number of single-access tower blocks. The LPS buildings were strengthened and the flat roofs were enclosed in frames clad with curved metal sheeting. The reporter is concerned that this could negate the opportunity for helicopter rescues in the case of fire. He suggests that there should be provision for a fireman to be lowered onto the roof to set up winching of trapped occupants. He is also concerned about the provision of fire alarms in tower blocks and says that there has not been any direct contact between the structural engineers and the Fire and Rescue Services.

CROSS comments: *It is normal in the UK for tower bocks to have a single stairway but not to have provision for helicopter rescues which is not generally regarded as a practical proposition for a number of reasons. Many of these buildings do not have fire alarms although there may be smoke alarms in individual flats. The landlords of blocks (in England and Wales) are obliged to produce a Fire Risk Assessment under the Regulatory Reform (Fire Safety) Order which should cover the concerns being expressed. An important aspect is the fire rating of the structure which may well be in the range of 1 - 2 hours.*

UNSTABLE CONCRETE BLOCKS (Report 174)

A reporter from a consulting firm was called to a site where the blocks in a retaining wall were found to be expanding and falling apart. After consultation with an expert it was decided the cause was most likely to be faulty aggregate that was expanding when wet. Having established that his Client was not to blame for the faults the reporter had no further input in this case. The firm was however subsequently asked to look at a site where concrete blocks from the same manufacturer have been used in a 2m high retaining wall, precast concrete floors and 2m

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
- Health & Safety Executive
- Highways Agency
- Institution of Civil Engineers
- Institution of Structural Engineers
- Local Authority Building Control
- Scottish Building Standards Agency
- UK Bridges Board

deep foundations to the internal walls of two of the houses. The blocks used in the retaining wall were showing the same problem as seen in the initial job. The image is of one of the remaining pallets on site illustrating blocks that have been soaked after a period of wet weather.

Cracked concrete blocks

The reporter is concerned that similar blocks may have been used in structures that could put the public at risk if they become wet, deteriorate and fail. Local Authority Building Control has been informed but they have advised that there is little they can do, and suggested that the reporter speak to the HSE. The reporter wishes to be sure that his firm has discharged its Duty of Care.

CROSS comments: *This looks like a severe case of reactive aggregates where blocks are completely breaking up. This type of progressive cracking can occur when there is a high moisture contents (e.g. blocks get wet on site during storage or in a partially constructed situation). It emphasises the point of procuring blocks (and other materials) that comply with British Standards from a manufacturer who can give a quality assured history of the product and its constituents. Once built in it is very difficult to rectify these situations. The standards which apply depend upon the application for which the blocks are to be used. CROSS is keen to hear of similar examples in order that a broader picture may be established.*

INSUFFICIENT FEES (Report 190)

An existing commercial building is to be converted to flats with an estimated contract value of £1.5m. The client has appointed a sole proprietor business. The main concern of the reporter is that the fees for a full investigation of existing structure, addition of an extra floor, and full design and drawing service was £4,300 i.e. about 0.3%. This is considered an order of magnitude too low with normal fees closer to 2% and ideally 3% inclusive of investigations and RC detailing.

CROSS comments: *This is an oft repeated tale, particularly in difficult times. However, strictly it is not fees per se which determine the legal position but if a professional takes on a job for nothing he or she carries all the responsibilities regardless. The formal position is clear. The Client must ensure that he or she appoints competent parties, adequately resourced. The engaged party has a reciprocal responsibility and the CDM-C also plays an important role in this instance. Those appointing professionals so far below typical market rates should ensure that they have suitable qualifications and insurances.*

GAIN IN STRENGTH OF MORTAR SLOWER THAN CONCRETE (Report 177)

On a four storey load-bearing masonry residential scheme, steel beams were used where the walls did not align. To support these 600mm long padstones were required but four courses of Engineering

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FEEDBACK

With the 'Feedback' facility you can send comments on any aspect of CROSS 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 www.cross-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

INFORMATION WANTED

- **Snow load related failures**
- **Eurocode implementation issues**
- **Reactive aggregate cracking of concrete blocks**
- **Any recent HAC concerns**

HOW TO REPORT

Please visit the web site www.cross-structural-safety.org for more information or email Alastair Soane, CROSS Director, at dir.cross@btinternet.com

When reading this Newsletter online click here to go straight to the reporting page.

Post reports to:
PO Box 174
Wirral
CH29 9AJ
UK

grade B bricks were substituted (not by the designer) for the original in-situ concrete padstones on cost and handling grounds. The programme was such that the next floor of precast units was installed after a week, causing the brickwork to settle and crack. Whilst multiple unit brick padstones may provide an attractive handling and cost solution, it needs to be noted that the gain in strength and stiffness will be nearer the 28 days and that such padstones do not have the inherent robustness of an in-situ concrete component.

CROSS comments: *It is common practice for engineering bricks to be used at the top of walls to carry high concentrated load positions. Any wet placed material like masonry mortars or indeed in situ concrete need a period of curing to establish sufficient strength for loading. The full strength gain is normally expected to occur at 28 days, but loading of upper construction can take place earlier as usually only dead load is being added. At high load positions under beams, insitu or precast concrete spreaders are better options. They do need to be of the right proportions to distribute the concentrated loading and any bedding mortars need to be specified correctly with time given for them to reach a suitable strength to carry construction loads from above. Substitution of a component on site without reference to the designer is an unacceptable practice. This report illustrates the often significant difference between formal procedures i.e. no changes are made to the permanent works without a competent designer agreeing to them, and custom and practice on many sites where significant changes are made on a unilateral basis.*

LOADING REINFORCED MASONRY RETAINING WALL (Report 178)

A 2.5m high retaining wall was constructed as a reinforced masonry wall incorporating reinforcement in pockets on the back. Access requirements meant that the wall was backfilled two days after construction. A week later it was noted that the wall was no longer plumb. Investigations included excavating back to the base slab which had remained horizontal and it was found that the deflection was due to creep in the bed joints of the immature wall.

CROSS comments: *This is another example of early age loading - see CROSS report 177. With any retaining wall backfilling has to be done after adequate strength has been achieved. Early age calculations can be undertaken to assess this if required, as when backfilling needs to be early. This may have consequences for the original design (e.g. thicker wall, higher strength materials used, higher designation mortars used). The reporter suggests that there was 'creep' in the bed joints but it may have been horizontal slippage (bond failure) or shear strain. Contract specifications should always stipulate the basis on which loading is permitted on new construction where there are hardening processes involved to avoid this type of problem.*

Over the years a recurring theme has been trouble with small retaining walls and how they perform, and a number of collapses have been reported to CROSS and others. These are not major structures but the failure of a 2.5m high wall is sufficient to kill (as has been seen in previous reports), and such retaining walls, and indeed free standing walls, warrant proper engineering design and construction which includes consideration of backfilling. Failure can occur just after construction or can take years to occur.

DATES FOR THE PUBLICATION OF CROSS NEWSLETTERS

Issue No 19	**July 2010**
Issue No 20	**October 2010**
Issue No 21	**January 2011**
Issue No 22	**April 2011**