CROSS

Confidential Reporting on Structural Safety

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INTRODUCTION

In the 12 months since CROSS was launched reports have been received on: Building Control Issues, Collapses, Construction, Design, Engineers on Site, Materials, Near Misses, and Temporary Works. In this Newsletter reports are all related to existing structures. The Newsletters in which these are published have a potential readership of over 50,000 engineers and others in the construction industry not only in the UK but worldwide.

Every reader will have had experiences that they use in their own work to avoid future problems. If your reading of a Newsletter triggers recollection of a similar experience that you feel should be taken up then please make a report to CROSS. The goal is to provide an effective avenue for identifying real concerns (which are often not raised through other routes) in order to promote a culture of learning and influence action by Government, Institutions and other bodies. In time, the scheme will also become an important resource of knowledge for the construction community.

New buildings represent only a small proportion of the total building stock. As a national resource the number and value of old buildings is much greater and they need protection, maintenance and improvement. These matters are assuming more importance as energy efficiency, water savings, and other sustainability issues are increasingly relevant. Accordingly this Newsletter addresses concerns found with some older buildings, and the potential problems with conversions and alterations. Other reports received in the last three months will be held over for future Newsletters.

Reports from contributors have identifying features removed and may be edited to give more clarity and may be shortened, but the views expressed remain those of the authors. Comments given at the end of each report are those from the SCOSS sub group of representatives from the industry. Material from the reports will be used by SCOSS to detect trends so that appropriate action can be taken and advice given.

EXISTING BUILDINGS

Wind damage

A report from a client which owns a number of large industrial buildings says that a period of storm force winds, with wind speeds approaching design levels, resulted in damage to secondary roofing and cladding elements. The gross areas of roofing and wall cladding performed well. Certain secondary elements however did suffer damage in the extreme wind conditions. Inspections by the owner have shown that localised areas of secondary metal components such as flashings, trims, cappings and the like did become detached or distorted.

Investigations by the owner have also revealed that secondary elements may not attract the same attention in the design, installation and inspection process as do the main roof or wall areas. The detailing, fixing, and inspection of secondary elements must be rigorous to avoid potential damage in high winds and to avoid the resulting hazard of flying debris and any consequential weakening of the main areas of wall and roof coverings.

Comment This emphasises the need for designers and contractors to be careful with the detailing and selection of fixings for secondary components. Fixings have been mentioned in previous reports (Newsletter No 1, DI 006 and 007) and SCOTCROSS have had many reports (DI 031) of items falling off buildings. The frequency and severity of strong winds are predicted to increase as climates change so more incidences of such damage may be expected. (Report DI 042)

Newsletter Circulation

- *The Institution of Structural Engineers sends out 13,000 emails to members and fellows.*
- *The Institution of Civil Engineers gives a link on MyICE web pages for 35,500 members and fellows.*
- *The Newsletter is distributed in hard copy by BRE Press to several thousand subscribers. These are construction professionals from a wide range of disciplines including architects, consultants, surveyors, local authorities, contractors and clients.*
- *Some firms publish the Newsletter to their employees*

Presidents' letter

The President of the Institution of Civil Engineers Gordon Masterton, and the President of the Institution of Structural Engineers Michael Dickson, have written jointly to the chairmen and technical directors of contractors, specialist construction firms and consultants to promote CROSS and to encourage its use.

The letter can be found on the website www.scoss.org.uk/cross

Scottish Tenements

Tenements are characteristically of traditional construction, with stone outer walls and brick inner walls and party walls, typically 4 storeys high, but this can extend up to 8 storeys. Floor plans are repetitive, with variations at street level to accommodate main door flats in residential districts, or shops on commercial streets. Tenements appear massive and solid but (in the opinion of the reporter) many tenements are not particularly robust, and are quite vulnerable to accidental damage. The original construction would not comply with a number of present-day design requirements as there is a limited degree of tying of internal brick walls (including party walls) to external stone walls. If floor joists are removed, e.g. by fire damage, the system of walls may not have sufficient rigidity to remain standing. Again, if there is differential settlement of internal walls with respect to external walls, vertical cracking along their interface will weaken the wall system. There is limited tying of the floor joists running parallel to party walls or end gable walls. If the gable wall is weakened by, for example, a gas explosion, or if its foundation is undermined, progressive collapse of the tenement block may result.

If the tenements are built along an inclined street, the floor levels will be stepped, with the result that any lateral in-plane forces in the floors are transmitted into the next building by shear in the party wall. Beam/column "goal-post" frames such as those used in alteration work are not usually designed to resist lateral loading or bending. Floor-to-ceiling heights in tenements are often over 3.0 m high, leading to slenderness ratios of over 27 for 100mm thick load bearing brick walls.

Shallow foundations, with tenement walls built off large flagstones rather than concrete strips, are liable to differential settlement. In much of central Scotland, the bearing stratum is boulder clay, which has adequate compressive capacity for tenement loadings - however, some tenements are founded over old mine-workings or on the beds of rivers which have been diverted or routed into culverts. In such cases, large settlements or differential settlements may occur.

The low quality of bricks and lime mortar used for internal walls implies a low compressive strength for internal walls. In addition, a number of internal walls at ground level are bowed, or out of plumb and it may not be apparent whether this has developed recently or over many years. The clinker deadening installed between floor joists in the original construction increased floor mass and rigidity, and also damps any vibration of longer spans. On the other hand, the clinker serves to retain water from leaking plumbing or other water ingress, so encouraging rot of the floor timber. Due to the cost of high level access necessary maintenance such as pointing and removing leaves from gutters may be neglected. Pointing is sometimes carried out in cement mortar rather than the original lime mortar.

A number of tenements have bay windows with slender stone mullions. In many cases, the bedding planes of the sandstone used for these mullions runs vertically. As the stone of the mullions delaminates, the cross-section in compression decreases and stresses increase, reducing safety. The stonework at the bay windows is more slender than elsewhere in the external walls. To prevent buckling, many Scottish tenements have had steel restraint straps installed around the bay windows.

In commercial streets, the owners of the shops and public houses often want to remove internal walls to increase sales area and improve security. Taking down load bearing walls and installing beams is difficult to achieve without noise or movement transmitted to the adjoining properties.

The reporter believes that works involving major openings should include design details of temporary works and method statements for taking out walls. Generally, says the reporter, tenements should have an "MoT" type appraisal of their construction at 5-yearly intervals or following any structural alterations.

Comment This report about stone-built tenement properties in Scotland raises issues affecting the existing stock throughout the UK and elsewhere. The direct and practical comments are welcome. Engineers with experience of surveying old buildings know of the degradation that occurs by alteration, abuse, lack of knowledge and poor quality of workmanship. It is a real challenge to understand what the risks are and what balance to strike when deciding what work is desirable and what is

What should be reported?

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

Benefits

- unique reservoir of information
- better quality of design and construction
- possible reductions in deaths and injuries
- lower costs
- reduced concerns about liability

Founder supporters

- Association for Consultancy and Engineering
- Construction Industry Council
- Constructing Excellence
- Department of Trade and Industry
- Health & Safety Executive
- Institution of Civil Engineers
- Institution of Structural Engineers
- Department of Communities and Local Government
- Office of Government Commerce
- Scottish Building Standards Agency

A 'prop' spliced together from old floor joists

essential. SCOTCROSS has had numerous reports of masonry and other materials and components falling from such buildings and detailed reports will be published.

Some of these issues will be addressed at the ICE conference 'Structural safety across the Lifespan of Buildings' on 4th October 2006. The notion of having an MoT type report for buildings is interesting and the views of other engineers would be welcomed. In England and Wales the Home Information Pack to be introduced in 2007 will contain information on the condition of dwellings that are for sale. (Report DI 026)

Masonry support prop adaptor

A reporter has written to say that when carrying out temporary needling and propping of openings formed in masonry walls one of the most important aspects is to ensure that the props are concentrically loaded and plumb. BS 5975:1996 gives safe working loads on adjustable steel props that are plumb within 1.5° (i.e. not exceeding 25mm out-of-vertical over a height of 1m) and with no eccentricity in excess of 25mm. The use of a steel bracket on top of the prop, giving an eccentricity of about 200 mm would not seem to be such a good idea. Interestingly such a product does exist and, says the reporter, has proved very popular with builders who see the advantage of propping only one side of a wall. The prop is hired from builders' merchants with minimal safety instruction.

Comment An extract from a leaflet enclosed with the report is:

> *"Maximum load bearing capacity 340kg (750 lb) per unit*
> *Maximum safe working height is 3m from a firm base*
> *Designed as a cost effective labour saving device. It will fit any adjustable steel builders' prop with a 6" or 150mm square top plate."*

There is a sketch showing a plate on top of an adjustable prop with an angled brace going back to the prop. The prop is situated outside the wall face of a lintol and the eccentricity from any loading on the prop would be considerable.

The reporter is concerned about the prop being potentially unsafe due to bending moments being introduced by this product into props designed for axial compression. The quoted maximum safe working load (340kg) is considerably less than that for a 3m prop loaded according to the BS but any device that modifies the behaviour of props by introducing bending moments is potentially hazardous and should be reviewed by an experienced engineer before being used. Do other engineers have experience of similar products? (Report DI 032)

Removal of internal structure

A reporter was called to give a second opinion to a Building Control Authority which had made a visit to a site to find that the whole of the internals of a two storey building had been completely removed. This was a building which had been a row of 3 or 4 shops in a longer terrace and all cross walls and the first floor had been removed. The front wall was approximately 18m long with no returns. The roof trusses, 6m above the ground floor, had been left supported on props made by nailing floor joists together; one at each party wall position. There was possible evidence of wall plate movement on the front elevation. The building was liable to collapse and the road at the front was closed until the structure could be stabilised.

Several photographs were enclosed and a sample is shown on the left of one of the 'props' spliced together from old floor joists.

Comment This is one of several reports on dangerous temporary works during conversions of existing brick built buildings. It seems that whilst the designs for the final schemes are satisfactory and have Building Regulation approval, the contractors who have been involved have either not followed the designer's intentions, or have not had their own method statement, or have simply not appreciated the possible consequences of inadequate temporary works. Indeed HSE regards amateur house alterations as a significant area of risk and injury. In such cases if the structure is deemed to be dangerous a Local Authority can use its powers under the Building Act to make the property safe. Provisions that should have applied to the designers are the CDM Regulations, whilst the builders should have followed the CDM and CHSW Regulations. (Report DI 046)

COLLAPSE

Counterweight failure – Plank Lane Bridge

Bridge before failure

After failure with counterweight across carriageway

A component failure on a British Waterways' lift bridge has resulted in a 22 tonne counterweight falling some 5.0m onto a public highway. The road was not open to traffic at the time and there were no injuries. The incident was, nevertheless, serious and was followed by the closure of all British Waterways lift bridges of similar type until they were checked by Engineers and the risk of similar occurrences either ruled out or removed.

The lift bridge is of the Dutch style with an overhead counterweighted frame. It carries Plank Lane, an unclassified road, over the Leigh Branch of the Leeds – Liverpool Canal. The failed component was the connection between the counterweight and one of the longitudinal arms of the overhead frame. This was a bolted connection with eight bolts passing through the arms of the frame into threaded holes in each endplate of the counterweight. Only the bolt heads were visible and it was not possible to ascertain the bolt condition through normal inspection procedures.

One of the principal connections failed as the bridge deck was going through its normal closing cycle. Initial investigations indicate that the bolts in this connection yielded in shear. The actual cause of the failure is yet to be confirmed but sequential shear failure due to uneven distribution of load between bolts, fatigue due to cyclic loading and even accidental or dynamic impact loading are all possibilities.

Once this connection gave up the other principal connection followed suit in a twisting manner with a number of its bolts yielding in tension. The secondary cross bracing connections failed at the same time and the counterweight fell to the ground.

The road had been closed to vehicular and canal traffic under a weekend closure for maintenance on the bridge deck by British Waterways' contractors. No work had been done on the counterweight or its frame.

British Waterways' subsequent actions were to close all of its structures of a similar type and check them for hidden and inaccessible connections. Where these were found further investigations followed to ascertain the condition of the connections. In a couple of cases, where connections could not be immediately exposed, the bridges were kept out of service or alternative supports provided until the condition of the structures was assured. A full review of the maintenance and inspection regime for these structures will be undertaken in due course.

Comment British Waterways is to be congratulated on submitting this open report for the benefit of others. The issue is the importance of inspection to enable maintenance to be carried out. Accessibility for in service inspection is a basic requirement on any structure with moving parts. There is a fundamental difference between static structural engineering and cases where wear, vibration and fatigue are caused by mechanical movements. An ongoing theme at SCOSS is robustness and the possibility of the failure of one component leading to failure without warning. Such failures are also of interest to HSE to whom they should be reported in accordance with the Reporting of Injuries, diseases and Dangerous Occurrences Regulations (RIDDOR). (Report DI 047)

Local Authority participation

The Scottish Building Standards Agency has extended the SCOTCROSS scheme, which is recording falls of materials from buildings and near misses, for a second year. This is supported by the Scottish Association of Building Standards Managers. Results are very encouraging with 420 reports received in the first 10 months covering a wide range of circumstances. Most involve buildings around 100 or more years old and relate to problems with masonry and roofing. Two passers by have been reportedly struck by falling objects - fortunately their injuries were slight, and there have been several near misses.

Discussions are under way to consider reporting from some Local Authorities in England about concerns that they have. It is hoped that this will add a further dimension to the work of CROSS and SCOSS.

HOW TO REPORT

Please visit the web site **www.scoss.co.uk/cross** for more information.

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

Post reports to:
PO Box 174
Wirral
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Comments either on the scheme, or non-confidential reports, can be sent to **dir.cross@btinternet.com**