INTRODUCTION
The theme of this issue is the need for robustness. The Institution of Structural Engineers’ Practical guide to structural robustness and disproportionate collapse in buildings to be published in November 2010 will emphasise the importance of this aspect for both design and construction and will be of value to all engineers. Many collapses start with the failure of relatively minor components, such as fixings, and result in disproportionate damage and in risk to life. Achieving robustness is not difficult and usually not expensive but it does require a consideration of what might happen in various circumstances and the risks incurred. For example loads may not be precise, differential movements and secondary effects may produce unexpected stresses, weathering and corrosion may affect hidden components, and one in a series of fixings may fail and trigger a progressive collapse. The good designer, the good builder, and the good regulator need to be always aware of the need for robustness.

To make the SCOSS and CROSS programmes as effective as possible reports are needed on a continuing 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. Reports are edited to remove names and identifying details and are printed in normal text in the Newsletters. Comments from the panel of experts are printed in green italics. Reports together with comments are on the database.

DESIGN DEFICIENCIES IN CALCULATIONS SUBMITTED TO A LOCAL AUTHORITY (Report 210)
A Local Authority Building Control manager has sent a list which gives twenty nine of the more serious (and most typical) design-review queries raised by the Building Control structural checking process in his area over the last five years. This is within a predominantly rural Council. A third of the projects represent more serious risks to longer term safety. It is interesting to note, says the reporter, that all but two of the designers whose work was incomplete in some way were Chartered Engineers and members of either IStructE or ICE. The suggestion from other quarters would seem to be, says the reporter, that it is only amateurs producing beam calculations who pose any real danger. He continues: “Please understand, I am in no way criticising the status, qualification or technical excellence of a Chartered Engineer. I am, however, making the point that in a commercial world, where time is money, there is no real substitute for a genuine, independent third party check.”

From the detailed facts provided the following have been extracted:

<table>
<thead>
<tr>
<th>Type of building</th>
<th>Problem</th>
<th>Materials involved*</th>
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<tbody>
<tr>
<td>new build</td>
<td>dangerous structures</td>
<td>steelwork 13</td>
</tr>
<tr>
<td>modifications &amp; conversions</td>
<td>design defects</td>
<td>timber 7</td>
</tr>
<tr>
<td></td>
<td>other</td>
<td>masonry 5</td>
</tr>
</tbody>
</table>

*May be more than one material involved
NEWS REPORT

Architects and construction firm fined after worker falls to his death

An architect’s practice and a construction company involved in a development have been fined a total of £195,000 following a fatality on the site. The builder pleaded guilty to breaching Section 3(1) of the Health and Safety at Work etc. Act 1974 for failing to safely manage subcontractors working for it.

The platform access point from which the operative fell

The architects involved pleaded guilty to breaching Regulations 13 and 14 of the Construction (Design and Management) Regulations 1994, which require designers to take safety considerations into account. The builder was fined £75,000 and ordered to pay costs of £68,000 and the architect was fined £120,000 and ordered to pay costs of £60,000. The court heard that an operator was working for the builder’s sub-contractors on the air conditioning plant, which was built on a platform accessed via a ladder at the edge of a flat roof. The roof only had a low parapet, which was not high enough to prevent the operator falling nine metres to his death.

An HSE Inspector: "While it is rare for designers to be charged with breaching health and safety legislation, they must be aware they can be held responsible where bad design is an important contributory factor to a workplace fatality. Designers must ensure that plant and equipment can be accessed safely, and that safety harnesses are only used as a last resort. HSE will not hesitate to take enforcement action against any company or individual who fails to carry out their health and safety duties, especially when that failure results in a tragedy, as in this case."

Of the 13 steelwork cases 4 were new build and 9 were modifications and conversions whilst of the 4 concrete cases 3 were in foundations. Nine examples were from sole practitioners, 13 were from what are described as small practices, 5 from medium sized practices, and 2 were from “top 10” practices.

Some quotations from the report:

- New 35m span portal. Secondary moments in bracing connections, out of plane buckling restraint to main stanchions - too far from haunch and missing in some locations, fitted stiffeners designed (in calculations), but not on drawings, untied bases adjacent to service trenches.
- Loft conversion. 254 UC section primary beams seated on timber head-plate spreader with only single stud adjacent. No stud continuity to foundation level.
- New school hall. Gable end wall panel unrestrained - vaulted roof. No buttressing or wind posts - remedial work required.
- Timber framed warehouse. Post and beam structure provided with only 50% of required wind bracing.
- New public office building. Load bearing masonry design - 15m square. Engineer shows no buttressing walls or wind posts - inner skin 100mm. Also, no overall designer (as required by BS) - trussed rafter design, bracing details and girder fixings all inadequate.

CROSS comments: These demonstrate that problems can occur whatever the material used and whether or not the designer, or at least the person submitting the scheme, is qualified. This is not the usual view which is that unqualified persons are most likely to get it wrong, and it would be interesting to know how many of these examples had proper checking before submission. SCOSs has previously recommended that calculations have a front sheet giving the fundamentals of the design assumptions and a brief description of the structure so that those who check know what to look for. (see SCOS Biennial Report 16 Appendix C at: http://www.scoss.org.uk/publications/report/report16/)

DO BUILDING REGULATIONS APPLY TO REPAIRING A COLLAPSED BUILDING? (Report 212)

The building in question is mid 19th century mill with cast iron frames spanning 8m at 3.3m centres and jack arch floors. It has three storeys and a roof and is 24m wide by 67m long and was subject to a fire which resulted in the sudden collapse of part of the interior structure.

The reporter describes this as progressive collapse due to the failure of cast iron beams and shearing of the lower level cast iron beams and the collapse of the flooring. There was considerable damage generally and specifically to two massive masonry piers.

As the engineer for the works of remediation, the reporter notified Building Control authorities and, following consultations with them, recommended to the owner that the whole building should be
BOOK REVIEW

Structural Engineering Failures: Lessons for design by Dr Niall MacAlevey
Published by Amazon, 2010, in hard copy and on Kindle

This is a well written book that will appeal to all engineers and especially those who have an interest in failures and collapses. The author has collected examples from the past 100 or so years and summarises, in categories, the failures of 50 bridges and buildings from around the world. The names of some of the projects will be familiar to the more experienced practitioners but not to the younger members of the profession, and the reasons for many of the failures will not be well known. These have been succinctly summarised with comments on the lessons that could, and should, be learned. Indeed the work is studded with quotations from investigators about the importance of picking up on the causes of previous failures and getting these messages to designers through education and the dissemination of the experiences of others. Reasons for the failures include: inadequate appreciation of gravity or wind loads, material failures, design and construction errors, and explosions and extreme events (but not earthquakes). Well known lessons such as the importance of unusual wind effects or the need for care with shear in flat slabs are given in addition to examples involving inspections and the corrosion of hidden components and basic defects in modeling. There are recommendations on checking and quality, on robustness and redundancy, and on the relationships between designers and sites. The author brings his own perspectives to bear in recommending changes to Codes such as variable factors of safety according to the importance of structures. Overall there is a wealth of material which makes for a good read and the book is also valuable as a reference work with additional cross references for those who want to make more detailed studies. The point is well made that the vast majority of these collapses could have been prevented (or at least mitigated) by the application of knowledge that existed at the time. The work will be of value to young engineers as it shows how much there is to learn and to think about when dealing with large or unusual structures, and for the more experienced engineers where it can be a salutary reminder of the pitfalls that were encountered, and will be in the future, by even the most eminent practitioners of their era.

http://www.amazon.co.uk/s/ref=nb_sb_noss?url=se...earch-alias%3Daps&field-keywords=Niall+MacAlevey

upgraded to comply with the Building Regulations in respect of provisions against progressive collapse. He proposes to do this by introducing a new grid of beams to provide horizontal ties in each direction and considers that this is best practice.

CROSS comments: The issue of repairs to old buildings is a wide topic and some general views are offered here but common sense and the application of good conservation practice is often the way forward. The forthcoming Institution of Structural Engineers Guide on Robustness (due to be published in November 2010) recognises this dilemma and offers suggestions. The risk of progressive collapse in old mill buildings is real and historically it is documented that this happened even when they were under construction. Many hundreds of these buildings have been demolished because, usually without adequate maintenance, they became dangerous structures. The question of robustness of mill buildings is difficult. Some were built only to house machinery, where the load from the weaving machine was carried on the main beams, which fitted the drive belt arrangements for power from the steam engines in the boiler house. The brick arch floors were a later improvement to reduce fire risk from flammable materials when lit by candles or later gas lights and sometimes had minimal load carrying capacity. One hundred and twenty to one hundred and eighty years later, when rain and frost damage have weakened the structure, the risks are potentially high and difficult to assess.

The Building Regulations provide baseline standards, as do British Standards and Eurocodes and repairs may be considered in this light. There is no definition of "Repair" in the regulations, although there is an old definition from London Buildings Acts which says that if anything more than 25% of an element is replaced, it is considered a new element. It is not reported in this case that there is any material change of use or a material alteration, so the repair work must be no less satisfactory than the original; even if the original works did not previously meet the requirements (see Building Regulations 3.(2)). As the structure did not originally comply with disproportionate collapse requirements then the repaired building is not required to comply. This argument derived from Regulation 3(2) b is that the building is no worse than before. However a responsible Engineer, and indeed client, could well believe that the repairs should include measures to prevent disproportionate collapse, such as the introduction of horizontal ties as a matter of good stewardship and good practice. The forthcoming Institution of Structural Engineers guide on Robustness gives emphasis to the point that for engineers the Building Regulations are but one consideration. The engineer also has to consider duty of care and compliance with statutory duty, both of which point towards designing a ‘safe’ structure as is currently understood. This would mean giving explicit consideration to robustness and under CDM regulations this is a duty on the designer. If the building is a workplace then additionally: “…the building shall have the stability and solidity appropriate to the nature of the use of the workplace”.

DIVIDED DESIGN RESPONSIBILITIES (Report 151)

A reporter’s firm has taken on a commission to act as a consultant to a precast lintel manufacturer. On of the first projects they were asked to look at was the installation of some lintels at floor level of a development so that under floor cabling could be installed through walls, below a raised access floor. Having sized the lintels (to support 5m height of blockwork) the firm were then asked by the contractor to confirm the overall stability of the walls. It transpired that the brickwork sub-contractor had taken on a "works package" from the management contractor. The sub-contractor had apparently assumed design responsibility for their portion of works such that; wind posts had been sized and located by the wind post company and lintels were to be sized by the lintel company’s advisors (the reporter’s firm). “Overall” responsibility appears to have been apportioned out to individual
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

CROSS comments: There is a fundamental responsibility for someone to act as the overall designer, particularly in regard of stability and robustness, but also as overall co-ordinator for the structure. Most design codes have introductory clauses saying that there is a need for a single point of responsibility. The forthcoming IStructE Guide on Robustness, mentioned elsewhere in this Newsletter, makes it very clear that in all structural projects there should be one engineer with responsibility for overall robustness and stability. It is highly dangerous to parcel parts of the work up with consequent dangers across the interfaces and for the strength and stability of the structure as a whole. Engineers undertaking parts of the work must be careful to advise their clients that there should be one guiding hand and they should be careful to define the scope and limits of their design input.

THERMAL EFFECTS ON LONG SPAN CONCRETE CAR PARK BEAMS (Report 173)

While in the Gulf a CROSS correspondent received a report from an engineer in his company who had visited a car park built with a system using long span precast hollow core units. The pattern of cracking in the supporting beams showed that solar radiation was causing the units to bow upwards with the rotation at the ends forcing the supporting reinforced concrete L-beams to crack through friction at the bearing - contact was concrete-to-concrete with no provision for movement. The structure was three years old and had progressively worsened during each summer.

CROSS comments: The effect is acknowledged in some countries where it is referred to as “sun camber”. In principle the movement from solar radiation needs to be allowed for, or provision made in the detailing to prevent relative movement at the connections. The Concrete Centre’s Hybrid guide (www.concretecentre.com) includes references and details. As with all building and design activities the best results are not just purely a matter of stress calculation. It is fundamental that there is an appreciation of material behaviour and of probable deformations with appropriate measures being taken to accommodate predicted movements.

In 2006 New Civil Engineer published an article describing problems with a car park in the UK where solar radiation effects were apparently blamed for widespread concrete cracking and spalling. At the time the Standing Committee on Structural Safety (SCOSS) called for the reasons for the structural failure to be made public, but this has not yet come about.

CANOPY COLLAPSE DUE TO SNOW (Report 181)

During bad weather conditions in the winter of 2009 a school’s canopy collapsed. Luckily the school was closed at the time and no pupil or member of staff was injured. The cause of the collapse has yet to be identified and may relate only to this cantilever type of canopy. The incident occurred following a period of snow and ice and may also relate to the extra weight imposed on the structure by this. The reporter’s team is now looking at a number of similar structures across the same Authority. The team also asks if anyone has experience in their own Local Authority of applications being made for these structures and if anyone has had any similar problems.
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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

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

CROSS comments: Whilst the cause of this collapse is unknown the forthcoming IStructE Guide on Robustness discusses the issue of sensitivity to design assumptions. There is clearly some uncertainty in snow loading on small areas like this with the possibility of drifting and snow accumulation. It is a sound approach to assuring robustness that the structure does not suffer a gross change of state if one of the design loadings is marginally exceeded. More reports on snow related collapses will be published in a future Newsletter.

GLASS PANEL FIXINGS FAILURE (Report 182)

This report is from a local authority and concerns the risks that can arise from glass panels. A double-laminated glass panel measuring approximately 1.0m x 1.5m was dislodged by a customer on the first floor balcony of a nightclub. The panel fell approximately 5-6 m before striking four members of the public who were standing on the ground floor. One person sustained a serious injury. During the course of their investigation into the accident the local authority were advised of a nearly identical accident that occurred at another premises run by the same organisation some months before, and which involved the same glass panel design. Following these accidents the glass panel fixings at both locations have been strengthened. The local authority were then advised by the suppliers that the glass panel design was used in only a small number of premises, and the local authorities in the regions where these were located were contacted. The glass panels in question are supported in metal channels along the top and bottom, but the middle panels have no fixings along their vertical edges. This would appear to make them vulnerable if force is applied to the middle panels. The same authority reported that they had another serious incident involving glass panel designs in 2007. A glass panel was knocked out of its metal bracket fixings on a first floor staircase in a retail outlet and fell edge first, narrowly missing customers walking under the staircase, before hitting and seriously damaging the floor. As a result of these incidents inspectors are checking the integrity of all glass panel fixings identified on upper floor balconies and staircases during site visits. The reporter encourages all other local authority enforcement officers to do likewise.

CROSS comments: This is a good report as it shows the value of highlighting incidents to help prevent recurrence. It is also a reminder to designers (as with the ceiling failures previously reported in CROSS) that attention to detail on small units is just as important as carrying out complex structural analysis. It appears there was here a lack of the fundamental robustness which should be a feature of all structures. Balustrades/barriers have a design requirement under BS 6399-1: Loading for buildings, and also under the corresponding Eurocode EN 1991-1-1, although the UK National Annex has not yet included the balustrade loadings. Reference can also be made to BS 6180: Barriers in and about buildings. The importance of checking that balustrades/barriers meet these requirements particularly in relation to framed panels is emphasised by considering the consequences of failure.

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