CROSS
Confidential Reporting on Structural-Safety

For an introduction to CROSS see www.structural-safety.org. Email: structures@structural-safety.org

NEWSLETTER NO. 50, April 2018

REPORTS IN THIS ISSUE:

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 website database.

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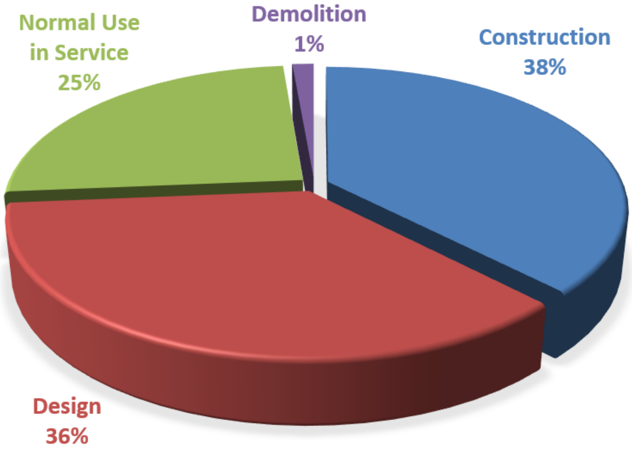
50TH EDITION OF THE CROSS NEWSLETTER

The first Newsletter was published in November 2005 with brief comments on a number of short reports under the headings: Near Misses, Collapses, Design Issues, Building Control, Engineers on Site, and Fixings. CROSS had started a short while earlier on a six month trial basis and we had no idea if the project would take off. Since then it has grown and is now the model for versions in other countries. The core topics have remained remarkably similar showing that lessons must be continuously re-learned so that safety culture can improve. Many thousands read the Newsletters in countries around the world and the number continues to grow.

Reports now tend to be about more serious issues, although the headings remain remarkably similar, and the comments from our expert panel are longer and more detailed. We continue to be non-judgmental and to give advice that will help others who are faced with similar situations to those reported. The Newsletters, SCOSS Alerts, and of course the CROSS Reports, are on our Structural-Safety database to provide a unique legacy of structural safety information.

None of this would have happened without the continuous support of our financial sponsors: The Institution of Structural Engineers, The Institution of Civil Engineers, and The Health and Safety Executive. Particular thanks go to IStructE and their staff who, as lead sponsors, provide essential services in addition to generous funding. Nor would anything have happened without the unstinting services of our voluntary SCOSS Committee and CROSS Expert Panel. Some of the personnel have changed over the years but the levels of commitment and undiminished enthusiasm have remained. Special thanks go our previous chair Professor Gordon Masterton, and our current chair Bill Hewlett, for their leadership and far-sightedness. The most important component of all is the commitment of those who report their safety concerns or event descriptions to us. Their support in providing the material from which we can learn, and which benefits the public and the construction industry is without parallel. The categories of their reported concerns or events gathered over the last 13 years is shown in the Figure below. Thank you all very much.



Project stage for reported safety concerns or events

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 Owners Forum
- British Parking Association
- Chartered Association of Building Engineers
- Construction Industry Council
- Department of the Environment
- DRD Roads Services in Northern Ireland
- Healthy and Safety Executive
- Highways England
- Institution of Civil Engineers
- Institution of Structural Engineers
- Local Authority Building Control
- Ministry of Communities and Local Government
- Network Rail
- Scottish Building Standards Agency
- Temporary Works Forum
- UK Bridges Board

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HOW TO REPORT

Please visit the website **www.structural-safety.org** for more information

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

If you want to submit a report by post send an email to the address below asking for instructions

Comments either on the scheme, or non-confidential reports, can be sent to structures@structural-safety.org

726 Combustible Insulation in Rainscreen Cladding

A tall residential building is being constructed in a UK city. Whilst walking past, a reporter observed the facade build-up to consist of combustible insulation with a rainscreen cladding. They have no professional involvement in the project and are unaware of its fire strategy; whether the facade build-up is an approved, tested system; or if a desk study was conducted for the project. However, in light of recent events, particularly for projects with a high number of sleeping residents, the use of combustible insulation causes the reporter great concern.

Comments

The reporter is right to be concerned after the large number of reported problems. It is only to be hoped that with all the publicity post-Grenfell that no current design or construction team can be unaware of the risk. However, prudence is required, and the general advice is as follows:

For a building under construction:

If you are concerned about work being carried out, in the first instance you may wish to notify the principal contractor responsible for the work. You can also contact the relevant local authority, who will have an interest in the safety of buildings in their area.

You might also contact HSE who is the enforcing authority in respect of fire safety during construction activities. However, concerns about the design of the building, materials used and adherence to Building Regulations are best referred to the Local Authority Building Control department. For an occupied residential building under refurbishment, the Fire and Rescue service are the authority responsible for general fire precautions in the building, such as means of escape, alarms and fire-fighting equipment.

For an existing building:

If you are concerned about the safety of an existing building, you may wish to notify the building owner. You can also contact the relevant local authority, who will have an interest in the safety of buildings in their area.

For an occupied residential building under refurbishment, the Fire and Rescue service are the authority responsible for general fire precautions in the building, such as means of escape, alarms and fire-fighting equipment.

SUBMIT SIMILAR REPORT

736 Building Extension Causes Snow Drifting Failure

Here is an issue, says a reporter, that many engineers fail to recognise and consider:

- Client instructs the extension to a standard steel portal framed single bay pitched roof factory to house EOTs (electric overhead travelling cranes).

- The extension is some 3m higher than the original thus creating an abrupt change in height.
- The structural engineer failed to realise that this creates the potential for drift snow accumulation in the end bays of the existing building.
- No check in accordance with BS6399:Part3:1988 is therefore carried out.
- Consequently, no localised strengthening of the end bays of the existing building is implemented.
- Building Control's independent checker, a Chartered Structural Engineer, also failed to identify the issue and allowed Building Control to approve the submission (alarming!).
- Heavy snow combined with gales caused significant snow build-up to occur at the interface.
- The roof elements in the end bay collapsed and damaged the penultimate bay.
- Both bays had to be stripped and replaced together with additional secondary members.

For many years the reporter has acted as an independent checker and conservatively "guestimates" that of all such submissions (i.e. involving extensions to buildings), at least 50% of the structural engineers failed to realise the implications of creating a valley or an upstand and failed to check existing structural elements including foundations for the increased load.

Comments

A significant cause of failures is simply overlooking a potential hazard. A second general cause of failures is poor change control and there are many classic cases of this. Failure to consider drifting snow is a common problem and not always limited to extensions. If the build-up of a drift does not cause collapse or excessive deflection, it can cause water ingress through the walls and windows at the back of the drift. It is an alarming statistic that so many engineers overlook what seems an obvious consideration and that it takes a good fall of snow to remind them. In general terms, this type of problem is associated with inadequate professional training. The recent "Beast from the East" storm in the UK (March 2018) resulted in heavy snow falls and significant drifting across large parts of the country. Structures may also be designed for snow drift loading to Eurocode 1 - Actions on structures - Part 1-3: General actions - Snow loads.

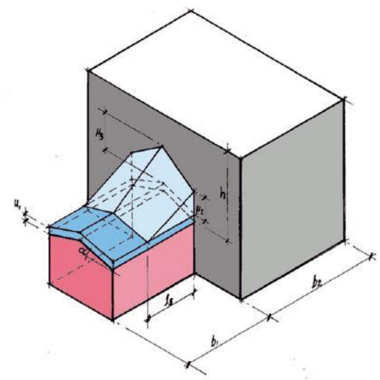

Figure 1: Snow drift loading (Ref. IStructE Technical Guidance Note - Level 1 - Note 5 - Derivation of snow load)

SUBMIT SIMILAR REPORT

665 Lack of masonry wall ties

A reporter was not surprised whatsoever when they read the SCOSS Alert on the Inquiry into the Construction of Edinburgh Schools. They state that they have come across the presence of serious defects in masonry construction in the past and have no doubt that many other engineers have had similar experiences. In one particular instance, they recall a concern on a large concrete framed structure constructed in the 1970s having extensive amounts of plain cavity brick cladding up to 15m high. Around 2010, they were asked to look at a general problem with this brickwork where, at horizontal intermediate masonry supports, there was spalling off of slip bricks and slight, local, outward movement of the panel above. The supports proved to have been very badly designed and poorly executed such that remediation work was needed. During the remediation works, the reporter was asked to look at a panel of the blockwork inner leaf. The panel was framed by columns and beams and, when pushed, swayed alarmingly. An initial investigation confirmed it had no functioning peripheral ties and almost certainly there were no functioning cavity ties. The reporter agreed with the client that a panel of the external masonry they were working on should be investigated further. This investigation proved to be disturbing, revealing very poor workmanship, limited numbers of ties overall, large areas with no ties, ties which had little or no embedment, loose ties and few ties restraining the panels back to the frame.

The reporter came across another startling instance on a very large, masonry clad, new build project in the mid-1990s, where they encountered the falsification of all the mortar test results. This was only discovered when the mortar began disintegrating before final completion due to lack of cement. Why this was done is a mystery to the reporter, but they wonder how many other similar projects lie undiscovered?

The reporter emphasises that these two instances were remediated, the first at considerable cost to the client and the second at great cost to the contractor. In the reporter's view, the basic problem is that masonry has too many variables, it is hard laborious work and human nature is to take shortcuts when no one is looking.

The reporter also comments on the Edinburgh Schools Independent Inquiry's gripe about the lack of 'As Constructed' drawing. They believe that no engineer or consultant could issue such drawings as they carry out only occasional visits and would have no full idea what the contractor has actually built. The best that can be done is 'Last Drawings Issued for Construction' which should include any major variations agreed with the contractor but cannot under any circumstances be representative of what has been built. In the reporter's view, if there is a necessity for such drawings, then there needs to be either a Resident Engineer or Clerk of Works to ensure the engineer's requirements are met.

Comments
Whilst this report contains many valid observations and highlights a problem with masonry, it is more beneficial to draw wider lessons. Any building is only as good as its detailing and innumerable examples can be given whereby structures as a whole have become unsafe because of lack of attention or because buildings can't be constructed to design assumptions. Although 'less glamorous' than mathematics, it must remain vital for all designers to have a sound grounding in basic principles of good building. Regarding ties, modern designers have probably forgotten severe problems on older structures due to galvanised ties corroding with age.

The use of Resident Architects, Resident Engineers and Clerks of Works has dramatically reduced over recent years. SCOSS has previously said that this deficiency must be recognised and addressed. Furthermore, public sector clients (and others) should require that tenders contain a full description of the proposed scope of design team services, including any proposed role in the inspection of the works on site.

To ensure masonry is correctly erected with ties, reinforcement, windposts, flashings and DPCs requires clear instructions to the bricklayers and their supervisor and also to the independent (Principal Contractor) supervisor. Builders should be 'encouraged' to engage competent, experienced skilled and semi-skilled site operatives. Those who have the power to do so must not be afraid to say; "take it down and start again". This is especially important in the early stages, to reinforce the message that walls must be built correctly. It is not practical to produce an "As Built" drawing to include location of all ties as they get built in very quickly and are then hidden. Radar scans can be done but are very time consuming, equally borescope surveys are possible if the cavity does not have full fill insulation.

Industry would welcome an innovation that either removes the need for brick ties, which as hidden but critical fixings are hard to manage, or provides a sure-fire, quick and easy way to assure that they have been installed correctly. A thought for researchers.

SUBMIT SIMILAR REPORT

735 INADEQUATE DESIGN OF CANTILEVER GLASS BARRIERS

A reporter has observed a growing number of cases where cantilever glass balustrades in public buildings are, in their view, designed inadequately. They believe the underlying cause for this is contradictions both within and between current design standards - clarity is required. Monolithic toughened glass is sometimes adopted, and laminated toughened glass is often adopted - neither are appropriate. Monolithic glass shatters into both dice and large clumps of glass, which can cause serious injury to occupants below. Monolithic glass leaves a gap in the barrier when it shatters. Even where a handrail is retained to span between adjacent glass panes, small children, buggies and wheelchairs may fall through the resulting gap. Toughened laminated glass is often specified, because toughened glass is the strongest form of glass and the inter-layer is assumed to prevent it from falling from its support. In fact, deflection tends to govern glass barrier design meaning that achieving the highest possible strength is generally not important. Furthermore, when both plies fail, laminated toughened glass loses its out of plane stiffness and collapses. In such circumstances, a standard PVB (polyvinyl butyral) layer is at risk of tearing, which would permit the entire sheet of glass to fall en masse. For occupants below, this is more dangerous than clumps of monolithic toughened glass. Such failures can occur despite the presence of a handrail. As with monolithic toughened glass, an unacceptable gap would be left in the barrier. Cantilever glass barriers should be designed with laminated glass that has at least 1 ply [preferably 2] made of heat-strengthened glass. Heat strengthened glass fractures in large pieces, which when combined with a PVB inter-layer, can span vertically between the base support and handrail.

The following design criteria are proposed for cantilever glass balustrades made with laminated glass:

- Design for strength using standard barrier loads; assume both plies contribute to resistance.
- Design for serviceability using standard barrier loads and deflection limits; assume that both plies contribute to resistance.
- Specify glass suitable for standard impact resistance.
- Assume that an accident occurs and 1 ply breaks.
- Design for strength using standard barrier loading; assume 1 ply contributes to resistance.
- Ignore the serviceability criteria.
- Assume that both plies break.
- Design the handrail to span between adjacent panes using standard barrier loading.
- Specify glass plies suitable for spanning between the handrail and base support after they have fractured.

Comments

This is an interesting report. There might be designers who disagree with the suggestions, but the report nevertheless highlights a key design task of looking at modes of failure first. It also highlights the need to consider the real possibility of 'failure' but then to question what 'failure' means and to assess an appropriate design offering least risk. The report addresses cantilever barriers but the topic would be equally relevant to many other glass designs where different conclusions might be drawn about the best type of glass to use.

A useful reference is Structural use of glass in buildings (second edition) published by The Institution of Structural Engineers in 2014. The Centre for Window and Cladding Technology (CWCT) based at Bath University is a source of guidance in respect to the type of glass to be used and in what combination in different situations. Within this is a requirement to undertake a risk assessment to ensure that if the glass fails the risk to the public is minimised. A further source is C632 - Guidance on Glazing at Height published by CIRIA. As the reporter says the use of an interlayer is not always the solution as it can deteriorate under UV light, or debond if water sits on top and works its way into the make-up. Glass configurations can also be subjected to impact testing for hard and soft bodies to mimic the effects of cleaning cradles or body impact.

To see other CROSS reports on balustrades enter 'balustrade' in the Quick Search box on the website. Feedback on this issue would be welcome.

SUBMIT SIMILAR REPORT

683 CORROSION CAUSES COLLAPSE OF STEEL FLOODLIGHT MAST AT FOOTBALL CLUB

This is an Alert that was issued by a Local Authority responsible for enforcing the Safety of Sports Grounds Act with the full co-operation of the football club concerned, after a floodlighting mast collapsed at their ground. The mast consisted of a single column fabricated from five lengths of steel tube which successively reduced in diameter. The mast had an opening with a detachable cover just above ground level. The mast was believed to be of a bespoke design and installed in 1969. The mast had been painted externally but had no protective coating internally.

Figure 1: Bottom of mast after removal

Figure 2: Upper part of door opening (note the crack at the top right of the opening)

Investigations have highlighted the following factors which contributed to the collapse:

- Moisture was able to enter the inside of the mast through corroded and unsealed brackets supporting the floodlight lamps.
- Moisture was able to enter the inside of the mast through gaps between the detachable cover and the tubular section.

- Drainage holes at the bottom of the mast had become blocked allowing water to gather in the bottom of the mast.
- In addition to losing water by evaporation, water is likely to have been able to escape when it reached the level of the opening. This led to the internal face of the column corroding below the level of the opening leading to a significant reduction in the thickness of the steel tube.
- A horizontal crack had developed in a corner at the top of the opening and it is possible that a similar crack had developed at the bottom of the opening.
- Strengthening plates around the opening appear not to have been long enough to transfer load back into the body of the mast.

An inspection of other columns after their removal also revealed extensive corrosion below the level of the door openings. Advice from the reporter to other clubs is as follows:

- Your maintenance regime for floodlighting masts at your ground should include a risk assessment for internal corrosion of steel tubes.
- A check for internal corrosion should be carried out by a suitably qualified person where internal corrosion has been assessed as a significant risk.
- Your maintenance regime should include a check for cracking around any openings in tubular steel masts.
- Your assessment of the structural adequacy of the floodlighting masts at your ground should include an assessment of the adequacy of any strengthening around openings in tubular masts.

Comments
This is a good example of the type of report CROSS continues to benefit from. Points to note are:

- *Lighting columns are often made of thin steel so the percentage loss of material due to minor corrosion may be significant in its effect on strength.*
- *The full stress demand will only occur in very high winds, or if resonance occurs. Consequently, the effects of weakening may not be noticed until it is too late i.e. with the risk of a mast failing suddenly.*
- *Wherever they are located, falling masts may injure but masts located in crowded places (like stadia) may be deemed to present a higher risk of injury consequence.*
- *In this case, the crack and its location are suspicious. Lighting columns have been known to oscillate and thence fail by fatigue. The risk of fatigue is enhanced by higher stress ranges consequent on thinning sections; by corrosion (giving stress concentrations) and at corners (again for stress concentrations). This crack is in a corner. Hence the advice to look for cracks in corners is very sound, not least as in this location, crack propagation rate is likely to accelerate with increasing crack length.*

There have also been experiences of failures of tubes just below ground level, so there should be means to inspect the internal face when designing for the future. Also, steel will not corrode without oxygen so maintenance should include effective sealing of holes provided for fixings and the original drain holes provided for in galvanising processes.

SUBMIT SIMILAR REPORT

740 Common use of S235 cold rolled steel instead of S355 hot rolled steel

It has come to a reporter's attention that some local (CE marked) fabricators are purchasing S235 cold rolled hollow sections rather than the specified S355 hot rolled sections, as they are easier and cheaper to obtain. This is also an issue with the main local stockist (who supply local fabricators) who say that there is no demand for the higher-grade steel; even though they fabricate from the reporter's drawings which specify S355 hot rolled steel. They tell us that they buy from Europe and it would be uneconomical for them to stock any S355 tubular products. They suspect that this is happening nationally and has been happening for some time. This is a surprise as they expect with the use of CE marking and execution classes, that there would not be this basic lack of understanding about the implications of incorrect substitutions. The reporter is not sure where this leaves them for work that has already been completed and what they might use in the future where a tubular product is most suitable if they cannot be sure that the correct grade will be used.

Comments
This report is in many ways very similar to Report 634 (see below). The allegation is not quite clear as to whether products are being incorrectly CE marked or whether contractors are substituting lower grade material without authorisation. Neither action is acceptable. As for Report 634, no changes should be made without sanction from the designer.

Major asset owners have had problems with the wrong (i.e. cheaper) grade of steel being used. A fundamental problem is that many within the supply chain do not appreciate that such product substitution results in a completely different product being used – a product with different design properties. For example, one could not simply substitute a hot rolled product for the same section thickness cold formed product – the equivalent cold rolled section would need to be thicker. This is because of the stresses induced in the steel during the manufacturing process – such stresses would not be induced in hot rolled steel. Hence, different manufacturing process, different stresses, different design properties. Also, substituting hot rolled for cold would be a serious problem in areas where the section would be subject to fatigue loading. Another implication would be welding – completely different welding procedures would apply.

Reliance on CE marking with no independent review may not be sufficient, and substitution must be guarded against. The SCOSS Alert Anomalous documentation for proprietary products - February 2013 warns of this practice. There are also CROSS reports on the subject: 338 Concern about CE marking for reinforcing steels, and 510 Policing of CE marking on steelwork.

SUBMIT SIMILAR REPORT

634 CONTRACTOR INSTALLS INCORRECT STEEL GRADE

A reporter came across an issue where the fabricator had used cold formed S235 commodity steel SHS rather than the specified hot formed S275 structural steel SHS. The change was discovered during a review of material certificates, after the job was finished. The project, in a football stadium, was for gantries to hold sound and lighting equipment (with access for technicians) slung beneath the stadium roof directly over the public seating. Apparently, the fabricator had difficulty getting the S275 steel and the steel stockholder told him the S235 was easily available and an acceptable alternative. The reporter did not agree, and the gantries had to be replaced using the correct grade of steel. An expensive lesson for the contractor but sadly all too common says the reporter.

Comment
It is not possible to distinguish different grades of steel simply by looking at them. Likewise, it is not possible to distinguish different grades of concrete just by looking at the cast material. To overcome this, it is important to operate a proper QA/QC system to assure that what is built is what it is intended would be built. There needs to be detailed specifications of workmanship and materials, and inspection and test plans to provide quality control to meet those specified requirements. This report also has echoes of a comment made for Report 736 about the vital importance of change control: never change anything unless the designer has agreed. This is a Golden Rule in temporary works management (BS5975 refers), where the Temporary Works Coordinator has a stated duty to ensure that design intent equals constructed manifestation.

SUBMIT SIMILAR REPORT

678 ARCHITECT CONDUCTS STRUCTURAL DESIGN OF SWAY FRAME FOR DOMESTIC PROJECT

A reporter looked at a project recently where the drawings had been produced by the architect, including a structural design. This showed a steel frame within a gable wall to create a new 5.2m wide opening using 2 No. 152x89UB posts per end with a 203x102UB supporting the inner leaf and 178UB supporting the outer leaf (but both beneath the floor/new lean-to roof). There was a note to say that the beams were designed as fully restrained. The method of restraint turned out to be with proprietary galvanised mild steel straps at 800mm centres. The reporter considered that the beams should be 2 No. 203x133x30UBs minimum as the lateral restraint was inadequate. Also, the foundations for the posts were inadequate. The reporter knows of quite a few architects who do this. They apparently use online programmes to do the design and just submit the calculations which include disclaimers at the bottom of each sheet. They can't understand why Building Control pass them and why IStructE aren't doing more to prevent it? He wants to know what he should do about this?

Comments
Restraints are only as good as the component stiffness to which the restraints are added. SCI Publication P360 Stability of Steel Beams and Columns provides guidance on the determination of buckling resistance of beams and columns. There is a tendency amongst some to think that small structures are not worthy of 'proper design', but any number of failures show this to be untrue. In the case reported here, it is possible to envisage excessive beam deflection, beam twist under eccentric loading, falling of masonry post buckling, global side sway of the frame in or out of plane, and so on. Unfortunately, as we all know, Building Control have finite resources, and this presents real risk.

SCOSS / CROSS have made their opinions known to the current consultation on Building Regulation and its enforcement.

A few years ago, a court in Italy fined a software house for claiming that their programmes could design seismically resistant buildings. Unqualified persons, including architects, should not design structures, although there is nothing about this in the Building Regulations. It is a basic principle that those who are registered professionals know the boundaries of their expertise and constrain themselves to work within their limits of competence. It is not uncommon for architects (and surveyors) to undertake structural design on what they consider to be minor elements of a building, but without sufficient training to properly understand the concepts. In addition, *they rarely have any appreciation of the dangers their lack of knowledge can cause! The matter will be raised with the RIBA.*

SUBMIT SIMILAR REPORT

The success of the CROSS system depends on receiving reports, and individuals and firms are encouraged to participate by sending reports on safety concerns and events in confidence to Structural-Safety. In addition to structural reports, we want weather damage reports for use in formulating future regulation and guidance. See What to Report.

Company Presentations
Structural-Safety are giving lunchtime presentations to companies who are interested in learning more about how CROSS and SCOSS operate and to show examples of CROSS Reports and SCOSS Alerts. For more information contact events@structural-safety.org.

If you have any comments or questions regarding this CROSS Newsletter, please Submit Feedback.

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