

# CROSS

Confidential Reporting on Structural Safety

## Newsletter 57 | January 2020

### Editorial

There is growing concern about the number of problems requiring remedial works in buildings. They result in additional costs, delays, reputational damage, and a loss of confidence in the credibility of parts of the industry. Revealing the causes of failures should benefit everyone and it is perfectly possible to have a no-blame culture whereby anonymised versions of failure occurrences can be published.

In cases where there is a legal dispute, parties will not disclose information which could either incriminate themselves or breach confidentiality obligations (such as for arbitration). Unfortunately, this means that some of the best lessons to be learned are often not available.

A further potential source of undisclosed information is the insurance industry which does not generally publish the lessons that might be learned from claims. Recent letters to **The Structural Engineer** discuss the rising cost of PI cover and its effects. One author has experienced a four-fold increase in premiums over the past two years which, in addition to affecting their business, is a reflection of the risks, actual or perceived, seen by insurers.

The same author asks whether the causes might be due to, amongst other factors: over-reliance on computer calculations, poor checking, and poor supervision on site. Rhetorical questions, although all have featured prominently in CROSS reports over the years and will continue to do so until the culture changes.

Another cause frequently mentioned is the very low level of professional fees which must affect the quality of service



**DIRECTOR:**  
Alastair Soane

that designers are able to give. To this can be added the sometimes iniquitous pressures from value engineering processes which may give neither value nor do they result in any engineering improvements. These factors are exacerbated by the refusal of some clients to have independent, or indeed any, inspections on site.

The industry is being forced to review its attitudes and conduct as a result of the Grenfell Tower fire, and we must strive to ensure that there is not a structural failure of similar magnitude due to some combination of the known, and frequently expressed factors reducing the safety of buildings. Clients, designers, contractors, lawyers and insurers must work together more effectively to share critical information and Structural-Safety will strive to achieve this aim. There are many precursors which we ignore at our peril and the opportunities that CROSS provides for the industry to learn and improve are more important than ever.

*Alastair Soane*

### CROSS

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### CONTENTS

- 885** Disproportionate collapse assessment of Large Panel System (LPS) buildings › **2**
- 866** Portal frame design and fabrication › **4**
- 832** Timber frame wall tie design › **5**
- 870** Principal Designers' obligations for temporary works › **6**
- 645** Response to report 614 on missing columns from drawings › **7**
- 617** Structures at risk from scour and erosion › **8**
- 854** Suspended ceiling partial collapse › **9**

### HOW TO REPORT

For more information, please visit the [How to Report](#) page.



If you have experienced a safety issue that you can share with CROSS, please [Submit a CROSS Report](#).

If you want to submit a report by post, please send an email to [cross@structural-safety.org](mailto:cross@structural-safety.org) asking for instructions.

### KEY

- (R)** CROSS Report
- (C)** CROSS Panel Comments
- (N)** News
- (I)** Information

> Denotes a hyperlink

## 885: Disproportionate collapse assessment of Large Panel System (LPS) buildings

### REPORT

In the wake of the Grenfell Tower fire, there has been increased interest in the safety of residents of high-rise residential buildings, particularly from within the social housing sector, says a reporter. The fire safety of cladding has, with good reason, been the major focus of this interest.

However, not long after the Grenfell Tower fire, renewed concerns were raised regarding the risks of disproportionate collapse of Large Panel System (LPS) buildings. A gas explosion at the Ronan Point tower block in 1968 caused the disproportionate collapse of a substantial portion of the structure, with associated loss of life. This led to the structural retrofit of many LPS buildings in the UK, many of which remain in use today. On 5 September 2017, **MHCLG issued letters to local authorities and housing associations regarding LPS buildings**>, noting (in part) that:

*"Whether or not a gas supply is installed, it is important with all large panel system buildings that their structural history is known, and that their condition and continued structural integrity are understood and monitored"*

The reporter says that a number of local authorities and housing associations subsequently commissioned Chartered Structural Engineers to undertake assessments of LPS buildings under their control, and to provide the necessary assurances. The reporter has become aware of multiple examples of such assessments being undertaken and has had sight of some disproportionate collapse assessment reports issued by Chartered Structural Engineers to their clients.

On this basis, the reporter has become concerned by the approach being taken by some of these engineers to assess the risk of disproportionate collapse due to fire in LPS buildings - they essentially ignore such risks by invoking one of two justifications:

1. that risks associated with disproportionate collapse due to fire need not be carefully considered by Chartered Structural Engineers because a Chartered Fire Engineer is also engaged by the client, and that assessing risks associated with disproportionate collapse due to fire should be assessed (independently) by the Chartered Fire Engineer; or

2. that the Chartered Structural Engineers are able to assess the risks associated with disproportionate collapse due to fire as "low" based purely on their professional experience (without any examples or evidence given) and the fact that similar justifications have previously been accepted by Approving Authorities.

In the reporter's view, for the first case, the reasoning is flawed, as it is unrealistic to expect Chartered Fire Engineers to have the requisite detailed understanding of structural design and structural mechanics to undertake the necessary assessments. The reporter feels that this work very clearly falls within the professional remit of the Chartered Structural Engineer, and that it is unacceptable, unethical, and unprofessional to pass such important work off to individuals who cannot (in most cases) reasonably be expected to be competent to do it.

### The reporter has become concerned by the approach being taken by some of these engineers to assess the risk of disproportionate collapse due to fire in LPS buildings

In the second case, the reporter believes that vague justifications based on 'experience' without any supporting technical evidence clearly do not meet the expected professional standard for Chartered Structural Engineers to use reasonable skill and care in performing their professional duties. The reporter would expect some (even minimal) technical justifications to be given and backed up with calculations or analysis. Otherwise, they question the justification for accepting a fee for this work.

The reporter adds that simply because an unsupported technical justification has previously been accepted by Approving Authorities is no justification for taking the same approach again. Obtaining approvals based on precedent without evidential basis is unbecoming of a Chartered Structural Engineer, and should, in the reporter's opinion, be strongly condemned.

### INFORMATION

#### What should be reported to CROSS?

Structural failures and collapses, or safety concerns about the design, construction or use of structures.

Near misses, or observations relating to failures or collapses (which have not been uncovered through formal investigation) are also welcomed. Reports do not have to be about current activities so long as they are relevant.

Small scale events are important - they can be the precursors to more major failures. No concern is too small to be reported and conversely nothing is too large.

Your report might relate to a specific experience or it could be based on a series of experiences indicating a trend.

#### Benefits of CROSS

- Share lessons learned to prevent future failures
- Spurs the development of safety improvements
- Unique source of information
- Improved quality of design and construction
- Possible reduction in injuries and fatalities
- Lower costs to the industry

#### Supporters of CROSS

- Association for Consultancy and Engineering (ACE)
- Bridge Owners Forum
- British Parking Association (BPA)
- Building Research Establishment (BRE)
- Chartered Association of Building Engineers (CABE)
- Civil Engineering Contractors Association (CECA)
- Confidential Incident Reporting and Analysis Service (CIRAS)
- Constructing Excellence
- Construction Industry Council (CIC)
- Department of the Environment (DOE)
- DRD Roads Services in Northern Ireland
- Get It Right Initiative (GIRI)
- Health and Safety Executive (HSE)
- Highways England
- Institution of Civil Engineers (ICE)
- Institution of Structural Engineers (IStructE)
- Local Authority Building Control (LABC)
- Ministry of Housing, Communities and Local Government (MHCLG)
- Network Rail
- Royal Institute of British Architects (RIBA)
- Royal Institute of Chartered Surveyors (RICS)
- Temporary Works Forum (TWf)
- UK Bridges Board

The reporter speculates that Chartered Structural Engineers may be using either of the above two justifications because performing a defensible systematic risk assessment of disproportionate collapse due to fire in a LPS building is likely to be extremely difficult, and that many structural engineers do not have the required competence to do so. Structural engineers may also wish to shed the resulting liability.

In either case, the reporter considers it unethical and unprofessional to take this LPS assessment work on in the first place, and particularly to attempt to shed liability for this onto a Chartered Fire Engineer.

The reporter's expectation in such cases would be that the Chartered Structural Engineer works alongside a Chartered Fire Engineer to assess the risks of fire initiation, growth, and spread, and to then use this information to undertake a systematic assessment of the structural risks associated with disproportionate collapse due to a range of credible design fire scenarios.

## COMMENTS

The report of the [inquiry into the collapse at Ronan Point](#) > raised concerns over the safety of LPS buildings in fire, and in particular the effects of fire on structural behaviour of the building as a whole. Indeed, it was recommended that the regulations of the time were amended to include this. However, it appears that subsequent consideration of the issue concluded that provided adequate tying was present, progressive collapse due to thermal movements was unlikely.

If this is the case, then for an existing building where the adequacy of the tying is in doubt, clearly the recommendations of the inquiry with respect to fire are still valid. However, the original quality of tying may not be known, and corrosion may have had an effect after 50 years, so caution is needed.

There are difficulties when the assessment requirements cross two technical boundaries, which in this case is between a Chartered Structural Engineer and a Chartered Fire Engineer. The assessment of the risk of disproportionate collapse due to fire in LPS buildings is not a routine task and there will be few engineers who have relevant experience. Few structural engineers will have the sufficient understanding of fire, and likewise, few

fire engineers will have the necessary understanding of structural behaviour.

CROSS therefore supports the reporter's view that that a Chartered Structural Engineer should work alongside a Chartered Fire Engineer to conduct this assessment.

It is unacceptable if the assessment of the risk of disproportionate collapse due to fire in LPS buildings is not conducted due to the reasons presented by the reporter. As a minimum, a Chartered Structural Engineer should highlight the need for such an assessment even if they feel it is outside of their scope or expertise.

Many LPS buildings will be Consequence Class 3 in accordance with Table 11 in [Approved Document A](#) > and therefore will require a systematic risk assessment taking into account all the normal hazards that may reasonably be foreseen, together with any abnormal hazards.

Designers should not forget that responsibility for their design is theirs alone. Just because an approving authority has accepted their design does not absolve them of any responsibility. Approving authorities do not have responsibility for design, nor is their agreement any guarantee of safety.

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The reporter is correct to say that it is dangerous to use previous examples as precedent without fully understanding all the circumstances of why they have been accepted. In previous projects, there may have been mitigating factors which are not present in the project under consideration.

The IStructE have published a [Practical guide to structural robustness and disproportionate collapse in buildings](#) > and a [Manual for the systematic risk assessment of high-risk structures against disproportionate collapse](#) >. BRE have also published a [Handbook for the structural assessment of large panel system \(LPS\) dwelling blocks for accidental loading](#) >.

This report shows that it would be timely to re-consider existing guidance, or to have further guidance, on the assessment of LPS buildings.



SUBMIT REPORT



SUBMIT FEEDBACK

## NEWS

### Pedestrian bridge collapse in Miami - NTSB Accident Report

Following the collapse of a pedestrian bridge under construction in Miami on 15 March 2018, NTSB (National Transportation Safety Board) published an Accident Report on the collapse in October 2019.

[View accident report](#) >

## 866: Portal frame design and fabrication

### REPORT

A reporter, who is a chartered engineer, regularly designs commercial, domestic and agricultural steel portal frame buildings. They are also regularly asked to prepare structural calculations to support retrospective building control applications, which is usually as a result of a farmer or commercial building owner being reported to a local authority for not having applied for regulatory approval.

In such cases, the reporter always asks the fabricator who prepared the original design for calculations and is invariably told that "this is the way we always do it". In other words, there has been no structural design carried out and the fabricator has simply used the section sizes that they normally use for a particular shed size.

The reporter says that these sizes are often suitable for an enclosed shed but can be much too light for sheds with one or more open sides and the connections are more often than not inadequate. From the reporter's experience, a significant number of fabricators consider structural calculations as an optional extra which can be provided, but only if they are asked for to support a building control application.

The reporter recently met with a fabricator and erector after preparing calculations which demonstrated that a completed commercial portal frame was completely inadequately designed. Some of the issues were:

- haunches comprising simple flat plates i.e. no flanges;
- no full depth stiffeners which were required to prevent column web buckling;
- inadequate bolting arrangement at the eaves, and
- an unsuitable bracing arrangement.

The fabricator for this project agreed to carry out the required remedial work but stated that if they always had to work to 'a proper specification' they would never win any work. The reporter finds this very concerning as it may mean that, in many cases, portal frame sheds are being fabricated to a cost rather than to a proper design.

The reporter is regularly told by fabricators that there have never been any problems with their sheds, to which the reporter reminds them of the heavy snow of 2012 when there were a large number of portal

frame failures largely due to web buckling because of lack of full depth stiffeners and inadequate purlins.

**From the reporter's experience, a significant number of fabricators consider structural calculations as an optional extra which can be provided, but only if they are asked for to support a building control application**

### COMMENTS

What is being reported here is an approach where there is a real risk of a structural failure and building collapse. There is other evidence from previous CROSS reports that proper structural design and verification may be grossly inadequate for routine work such as domestic extensions and minor works. Inadequate structures in this market sector, along with agricultural buildings, pose a risk to life safety.

Portal frames need special attention, particularly for overall sway stability which depends on the rafters that are usually very slender. Furthermore, the members need consideration of the stability of the inner flange because this, or any plates on the inner face, may be subject to compression under either gravity loads or wind loads, so frequent restraints are needed. Restraint to the inner flange is commonly provided by diagonal braces to the purlins which must be of sufficient stiffness. There also needs to be adequate bracing so that the purlins are held in position.

Excellent guidance on the above and other aspects of portal design is given in Steel Construction Institute (SCI) publication **P397 Elastic Design of Single-span Steel Portal Frame Buildings to Eurocode 3**>.

It is usually most economical and safest to procure steel portal frames from a steelwork contractor who has design offices that regularly undertake the calculations for portal frames in addition to the drawings. The vast majority of structural steelwork in the UK is supplied by reputable steelwork contractors with recognised accreditations.

This is to ensure that the contractor is deemed competent with robust systems in place under 4 main headings:

- Product CE marking: mandatory under **European legislation**>
- Quality: **ISO 9001:2015**>
- Safety: **ISO 45001:2018**>
- Environmental management: **ISO 14001:2015**>

The issue highlighted by the reporter is that less than competent suppliers are cutting corners and failing to design steelwork. It is implied that some companies think it is acceptable to miss-sell the product and compromise their clients. In addition to the worst-case scenario where a building collapses, there are the risks of a prosecution and insurance policies being invalid due to a lack of structural design resulting in business or livelihood failure.

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Advice for clients looking to buy structural steelwork is to use a reputable steelwork supplier. The **British Constructional Steelwork Association (BCSA)**> is a trade organisation whose members are accredited, audited and employ structural engineers who design steelwork to the structural design codes required by the building regulations. There are other competence contractors who are not members of BCSA but this is readily shown by their CE Certificate - Factory Production Control to EN 1090-2. The challenge is to deliver this advice to clients who are not involved in the construction industry. It is understood that the BCSA are taking steps to address the situation.



SUBMIT REPORT



SUBMIT FEEDBACK

## 832: Timber frame wall tie design

### **R** REPORT

Wall ties are generally set out based on standard geometries rather than explicit design, says a reporter. In the case of masonry clad timber frames, the specification normally takes the form of a density of 4.4 ties/m<sup>2</sup>, with 3 or 4 additional ties per metre provided at wall edges and openings. This specification is understood to have followed over from Annex B of **BS 5268-6.1 (Structural use of timber - Code of practice for timber frame walls)** and is intended for use in urban areas only. Using this guidance, the general specification for new builds outside the urban area shelter effects would be a density of 7 ties/m<sup>2</sup>.

In blockwork construction, a specification of ties at 450mm centres, or every second course, along studs, is common. This is largely due to the geometry of the block, with the prescribed densities being better suited to brickwork. For studs at 600mm centres, this equates to a density of 3.7 ties/m<sup>2</sup>, which corresponds to **NHBC 2019 guidance (Section 6.2.14)**, but falls short of either of the above specifications. No adverse issues resulting from this lower tie density are known to the reporter.

A density of 3.7 ties/m<sup>2</sup> is mentioned in reference to contribution to racking resistance in both BS 5268-6.1 and the **IStructE Manual for the design of timber building structures to Eurocode 5**, without reference to where such a specification would be acceptable.

Tie capacities are provided in Table B.3 of BS 5268-6.1. When the global safety factor of 4.2 in clause 4.13.5 is applied, the permissible tensile and compressive load capacity for a Type 5 wall tie at a density of 4.4 ties/m<sup>2</sup> would equate to 0.63kN/m<sup>2</sup> and 0.45kN/m<sup>2</sup> respectively. The reporter says that the design wind loads for a significant proportion of buildings within the permitted geographical locations would be above these values.

Unlike other non-contradictory information in the British Standards, none of this wall tie information from BS 5268-6.1 has appeared in the Eurocodes, National Annex, or relevant Published Document to date, says the reporter. They add that correspondence with relevant specialists has suggested that as the Eurocode suite is more material specific, wall ties for connecting timber frame inner leaves to masonry outer leaves have not been adequately considered.

**BS EN 845-1 (Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets)** does cover wall ties for timber frame construction, but directs the reader to **BS EN 1996 (Eurocode 6 - Design of masonry structures)** and **PD 6697 (Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2)**. The National Annex to BS EN 845-1 states that the material factor for ties is to be taken from BS EN 1996, presumably overlooking, in the view of the reporter, the use of ties in arrangements other than traditional masonry cavity construction.

In summary, the reporter believes that the combination of the large material factor of 4.2 combined with the low capacities of the ties, means that there is no clear way to demonstrate the adequacy of timber frame wall ties to current guidance in areas of moderate to high wind loads.

The reporter does however suggest a potential solution, which would be to use a material factor relevant to each specific failure mode; 3.0 for mortar failure (from BS EN 1996-1-1, Table NA.1), 1.15 for the tie in bending (from BS EN 1995-1-1, Table NA.3) and 1.3 for pull out of a fixing (from BS EN 1995-1-1, Table NA.3). They conclude by saying that generally all failures result from bending of the tie, and a material factor of 3.0 would therefore be conservative. If a future amendment to BS EN 845-1 were to require manufacturers to test a sample of the ties to ultimate failure in the various materials, the results would offer greater confidence to designers. Alternatively, a requirement for failure in mortar and timber to be 2.7 and 1.5 times greater than failure within the tie would remove the need for more complicated published data.

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### **C** COMMENTS

As in report 866 in this Newsletter, the report demonstrates that the viability of any structural system depends on the detailing/connections and design assumptions being realised. The importance of adequate ties is amply illustrated in the **SCOSS Alert following the Inquiry into the construction of Edinburgh Schools** in 2016.

As far as the prescriptive guidance is concerned, the reporter is correct. Note that specifying ties at every course of 225mm blockwork at 600mm centres gives a density of 7.4 ties/m<sup>2</sup>, which is excess of the 7.0 ties/m<sup>2</sup> given in BS 5268-6.1 for exposed locations. The guidance in BS 5268-6.1 has not been reviewed since 2007, and the standard is not maintained by the British Standards Institution (BSI). As the reporter notes, the guidance in PD 6697 is for masonry construction, and there is no equivalent guidance in PD 6693 for timber frames.

Clause 5.4.2.3 in **BS 8000-3:2001** (Workmanship on building sites - Code of practice for masonry) states that the maximum spacing of ties for masonry clad timber frames is 375mm vertical centres for studs at 600mm centres, and 525mm vertical centres for studs at 400mm centres, which gives equivalent densities of 4.4 ties/m<sup>2</sup> and 4.7 ties/m<sup>2</sup> respectively. This standard is currently being updated to be published in 2020, but CROSS understands that the guidance on wall ties for masonry clad timber frames will probably not change.

As far as the calculation route is concerned, the principles of the Eurocode design path are well established for using structural products. Characteristic values for the product are determined in accordance with a harmonised standard (hEN), if one exists for the product, and the designer applies the appropriate safety factors to reach a design value.

As the reporter indicates, EN 845-1 is the hEN for cavity wall ties, and it specifically considers asymmetric ties where one end is in masonry and the other is in timber. The Declaration of Performance / CE marking that a manufacturer is obliged to provide will state the lowest value for tension failure, whether the failure is in the timber fixing, the mortar bed or in the bending of the tie. Older certificates may not include the failure mode, but those that are compliant with the current 2013 version of the hEN will have it.

A partial material safety factor ( $\gamma_m$ ) for wall ties of 3.0 is given in Table NA.1 of the NA to BS EN 1996-1-1 2005 +A1 2012. It may be halved “when considering the effects of misuse or accident”. As the reporter notes, this does not appear to reflect the possible variation in failure modes for timber frame wall ties, but given the equivalent factors for timber and steel are 1.3 and 1.1 respectively, a value of 3.0 or even 1.5 is conservative.

The reporter’s final paragraph provides a reasoned answer to their own concern. If the failure mode is known, the appropriate factor can be applied; if it is not known, the default factor is conservative. Many wall tie manufacturers are well versed on this issue and will often provide free design and assessment services.



SUBMIT REPORT



SUBMIT FEEDBACK

## 870: Principal Designers’ obligations for temporary works

### **(R) REPORT**

A correspondent has contacted CROSS as they are concerned by the Principal Designer’s obligations for temporary works as stated in Clause 8.5 of the new **BS 5975:2019 standard (Code of practice for temporary works procedures and the permissible stress design of falsework)**>.

They believe that the standard places some onerous duties on the Principal Designer which are a long way removed from site work and question whether many Principal Designer organisations will have the competence to coordinate temporary works designs in an effective manner.

They worry that we have gone from a single ultimate point of responsibility for temporary works to a situation where there is a confusing overlap of duties, roles and responsibilities.

The correspondent concludes by asking if anyone is aware of any guidance on how this will work in practice?

### **(C) COMMENTS**

The Temporary Works forum (TWf) is a source of useful information on this topic, including the publication of **Information Sheet 3 - CDM 2015 - Principal Designer: Guidance on Temporary Works**> in 2017. This document states that the Principal Designer should, at an early stage, discuss and agree with the Client their approach to the delivery of the role with respect to temporary works. Another useful reference is the **Temporary Works Toolkit**> published in The Structural Engineer.

It is important to remember the distinction between the duties as required by law, and recommendations provided by industry guidance. CDM 2015 sets out the legal duties of the Principal Designer, whereas BS 5975 provides authoritative industry

guidance on how those legal duties might be complied with. The Principal Designer is free to ignore the guidance if they wish, or do something different, but ultimately they must ensure that they comply with their lawful duties as set out in CDM 2015.

Further to this, CDM 2015 does not distinguish between permanent works design and temporary works design; they are both design as far as CDM 2015 is concerned with the same duties imposed on Designers and Principal Designers of both permanent and temporary works.

It is up to those organisations providing Principal Designer services to ensure that they have the necessary capability to undertake the role either in-house or by making suitable arrangements to supplement their capabilities. If not, they are potentially in breach of CDM 2015 Regulation 8(1) which requires that “A designer (including a principal designer) or contractor (including a principal contractor) appointed to work on a project must have the skills, knowledge and experience and, if they are an organisation, the organisational capability, necessary to fulfil the role that they are appointed to undertake, in a manner that secures the health and safety of any person affected by the project.”

**It is up to those organisations providing Principal Designer services to ensure that they have the necessary capability to undertake the role either in-house or by making suitable arrangements to supplement their capabilities**

The statements and intent within the updated BS 5975 look to direct Clients to engage Principal Designers that can provide the support that CDM 2015 intends, with guidance on temporary works coordination and the consideration of permanent works and buildability.

Items which a Principal Designer could consider in relation to temporary works include:

- ensure that the permanent works designers have identified a coherent construction method which identifies all key temporary works requirements;
- ensure that adequate temporary works coordination processes are in place;
- ensure effective communication between permanent works designers and temporary works designers;
- provide relevant information that may affect temporary works;
- if temporary works (and their risks) can be eliminated by designing the permanent works in a different manner;
- how risks for temporary works, if they are required, can be minimised;
- determining if there is sufficient space for temporary works during construction, maintenance and demolition;
- determining if other stakeholders need to be consulted about any temporary works.

There may be other considerations depending upon the circumstances.



SUBMIT REPORT



SUBMIT FEEDBACK

## 645: Response to report 614 on missing columns from drawings

### **R** REPORT

A reporter was very interested to read **CROSS Report 614** on drawings that contained missing columns and wanted to share their views on the issue. They agree with the CROSS Panel's comments that it highlights the need for drawings to be checked by a competent engineer.

The reporter believes that errors often manifest themselves in the drawing and the subsequent checking process, and not in the design. In report 614, the columns may have been missing from the BIM model used to create the drawings, or they may have been included in the BIM model but were terminated at the wrong level. In the latter case, the base of these columns could be terminated above the slab and therefore above the cut-line for the view that generates the drawings, meaning that the columns would not appear in the drawing for that slab level even though they were in the model.

The reporter says that one way of checking is to overlay the column layout from the BIM model with the column layout in the structural analysis model. However, a column which is simply missing from the BIM model may not be identified as the checker might wrongly assume it is obscured by the column from the structural analysis model in the same location.

The reporter believes that a more robust method of checking is to export an IFC file from the structural analysis model to the BIM model, where it can be imported as a 3D file in a different colour and the model can be interrogated more fully than a 2D DXF layout permits.

They go on to say that the method relies on the model being created perfectly, as any small errors mean that an element becomes corrupted and so doesn't copy over into the IFC file. The reporter encountered this on another project, where none of the walls and some slabs didn't copy over into the IFC file because of miniscule geometric imperfections. There may be settings within the software that enable this to be overcome, but the point serves to highlight the need to enhance our knowledge of how to use the tools as much as maintaining our core competencies.

For the reporter, the near-miss in report 614 highlights the importance of a robust checking regime. If a quality control system had been in place prior to this project, then the near-miss may have been avoided. In their view, a quality control system is not just a paperwork exercise, but if done properly, acts as a guide to help an organisation avoid errors. It also highlights the importance of rigorously checking the drawings; these are, after all, what the contractor uses for building.

### **C** COMMENTS

The reporter is thanked for sharing their views on how to implement robust checking systems for BIM models. All designers are potentially fallible, and it is prudent from a commercial and safety perspective to have work properly checked. Moreover, a fairly regular theme in CROSS reports is one of how easy it is to miss a gross mistake like the missing columns in CROSS report 614.

Part of the issue during checking is the desire to go from 3D back to 2D because we have been programmed to view in 2D and see in 3D. As 2D drawings are used to build from on site, some basic checking in 2D is required, but now that the 3D tools are available, should better use be made of them for checking?

One CROSS member worked on a large steel frame building project where BIM was used but all checking was done in 2D. It was only the diligence of the 3D CAD technician that showed that how a complicated part of the structure did not actually work. In the world of 2D, this would have been missed and would probably have led to heated discussions during construction about who had responsibility for final geometric co-ordination.

CROSS would welcome better guidance on this issue so that there is a way to show that checking has been conducted in 3D as well as 2D.



**SUBMIT REPORT**



**SUBMIT FEEDBACK**

### **N** NEWS

#### **CROSS Report 789 Temporary stability of steel frame building - Feedback from the HSE BIM 4 Health & Safety Working Group**

The HSE BIM 4 Health & Safety Working Group met in December 2019 to consider how BIM can make a difference and improve safety in cases such as that described in CROSS report 789 Temporary stability of steel frame building.

[View feedback >](#)

### **N** NEWS

#### **Adequacy in structural fire engineering lecture**

Luke Bisby, Professor of Fire and Structures and Head of Research Institute at The University of Edinburgh, discusses fire resistance design, how Chartered Structural Engineers can be confident that they have discharged their professional duties when designing structures for fire, and how they can assess whether their approach is appropriate.

[View lecture on IStructE YouTube channel >](#)

## 617: Structures at risk from scour and erosion

### REPORT

Following the **structural failure caused by scour at Lamington viaduct**> and the **Whaley Bridge dam collapse**>, a reporter is concerned that asset owners may not fully realise risks associated with scour and erosion, have poor systems in place to identify vulnerable structures, and be unwilling to spend the money required to implement remedial work.

They are also concerned that embankment structures, not just dams, may not be adequately assessed for risk of scour and erosion because they are often assessed by engineers who may not have relevant experience.

They say that there are numerous examples of failure in this field and that this is likely to get worse with increased flooding due to climate change.

### COMMENTS

Scour has been the cause of many major collapses. The occurrence of scour cannot be easily identified by inspection and collapses as a result of scour might happen suddenly. These twin effects violate a structural safety principle that the onset of any failure should be detectable and should give ample warning. For those reasons, scour failure is not a preferred failure mode and design against scour should be robust.

The **collapse of the Malahide viaduct**> in Ireland in 2009 was caused by scour and it was fortunate that no one was hurt.

This report is increasingly relevant with increases in floods and the possible consequential effects on bridge foundations, and also on some building foundations. Indeed, the risk of scour needs to be considered in a more holistic manner considering the influence of a range of factors including dredging/sand or gravel removal, removal of weirs near bridges and the influence of flood defences on the speed and flow of the water.

**The occurrence of scour cannot be easily identified by inspection and collapses as a result of scour might happen suddenly. These twin effects violate a structural safety principle that the onset of any failure should be detectable and should give ample warning.**

In 2018, Network Rail updated their **Scour Assessment of Bridges, Culverts and Retaining Walls**> document which describes the procedures for safeguarding their structures from the risk of scour.

Highways England, who maintain the Strategic Road Network in England, have a process in place for the inspection, assessment and monitoring of existing highway structures for scour and other hydraulic actions. The process, including requirements and advice, is provided in the **Design Manual for Roads and Bridges (DMRB) document BD 97/12**>, which includes detailed requirements and advice on risk management for scour and other hydraulic actions on highway structures.

Additionally, Highways England's document for the design of highway structures for hydraulic action (**CD 356**)> provides practical requirements and guidance for designers to determine hydraulic actions which are either not covered or covered in insufficient detail in the Eurocodes.

Highways England also conduct planned geotechnical inspections in accordance with the DMRB. These inspections are specifically required to observe/record the topography and condition of land adjacent to their assets. Where rivers, lakes or the sea abut or run close to their assets, the inspections necessarily include the recording of any land scour or risks of scour.

Management plans are developed from the asset condition reports, and appropriate repairs or mitigations are routinely undertaken within a timescale governed by the risks presented.

The value of such plans has to be judged in the context of the predicted greatly increased rises in sea levels and the consequential effects on the world's infrastructure. See for example reports from the **Intergovernmental Panel on Climate Change**>.

The **Reservoir Act 1975**> puts certain duties on dam owners to appoint qualified Panel Engineers to supervise their construction, inspection and maintenance. The Environment Agency, and the Scottish Environment Protection Agency (SEPA) in Scotland, monitors and enforces compliance with the Act. However, there are many embankments and minor structures and buildings that do not come under a specific inspection regime.



SUBMIT REPORT

SUBMIT FEEDBACK

### NEWS

#### SCI Advisory Desk Note 435 - Beams supporting precast planks: checks in the temporary condition

The Steel Construction Institute (SCI) have published a note to remind designers of their responsibility for basing their design on a safe method of erection. This is particularly necessary if structural stability in the part-erected condition is not evident.

[View SCI Advisory Desk Note 435>](#)

## 854: Suspended ceiling partial collapse

### REPORT

A reporter was asked to investigate the partial collapse of a suspended ceiling formed from a lay-in grid with medium weight acoustic tiles in a school classroom. Fortunately, although the room was in use, nobody was harmed.

The building and ceiling were less than 10 years old. The ceiling was fixed to the underside of a timber joisted roof by wire hangers. The underside of the roof had a layer of plasterboard attached for airtightness such that the joists were not visible.

For supporting the suspended ceiling, eye bolts were screwed into some joists. In other locations, short lengths of inverted ceiling grid were used to bridge between joists, and these were fixed back to the timber joists with two or three 32mm long drywall screws at each end. The effective embedment of the screws into the joists was approximately 10mm having passed through the inverted grid and the plasterboard.

The failure of the suspended ceiling was initiated at a location where the screws to fix the inverted grid to the joists had missed the joist and were only screwed into plasterboard at one end of the inverted grid. The failure progressed along two other fixing points for the inverted grid and stopped where the suspended ceiling was supported by an eye bolt screwed into a joist.

The specification did not directly state how the suspended ceiling was to be fixed to the roof, but did refer the installer to BS8290-3 (already superseded at the

time - now replaced by **BS EN 13964:2014 Suspended ceilings - Requirements and test methods**>, which did require a minimum screw embedment of 38mm into the underside of a joist, says the reporter.

In the view of the reporter, errors in workmanship caused this failure but contributory causes were both the lack of a clear specification and effective supervision of the work.

### COMMENTS

Failures of ceilings are a recurring problem. In addition to the example in this report, there was a recent **failure of a ceiling at a theatre in London**> and another **collapse at a shopping centre in Paisley**>. The CROSS database contains a number of other ceiling collapses (enter "ceiling" as a key word into the Quick Search box on the website).

In 2015, the **Best practice guide - selection and installation of top fixings for suspended ceilings**> was developed by the Finishes and Interiors Sector (FIS), the Construction Fixings Association (CFA), the Standing Committee on Structural-Safety (SCOSS) and other industry experts, as a guide to best practice on the choice, installation and testing of fixings for suspended ceilings.

The 2014 SCOSS Alert on **Tension systems and post-drilled resin fixings**> listed further CROSS reports on ceiling failures and provides guidance on the design of new ceilings and for the checking of existing ceilings. A 2019 article in The Structural

Engineer on the **Safety of hanging systems: lessons from CROSS reports**> is another useful reference. It appears that ceilings do not receive the level of attention, both in design and construction, that the potential consequences of failure deserve.

The failure in this report follows a familiar pattern; a progressive collapse initiated by a single hanger failure, with that initial failure precipitated by connection failure. Self-evidently, the hanger loads were uncertain and using wire hangers would not permit any meaningful control of hanger loads. A division of design responsibility and an inability to inspect also appear to be contributing factors to this failure.

### A division of design responsibility and an inability to inspect also appear to be contributing factors to this failure

Designers should also remember to check Contractor's Design Portion (CDPs) listed in the contract to ensure there is clarity about design responsibility and what liaison is required.



SUBMIT REPORT



SUBMIT FEEDBACK

### PARTICIPATION

The success of the CROSS scheme depends on receiving reports, and individuals and firms are encouraged to participate by sending reports on safety issues in confidence to **CROSS**>.

### FEEDBACK

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

### CPD PRESENTATIONS

Structural-Safety are giving lunchtime presentations to organisations who are interested in learning more about the work that Structural-Safety (CROSS and SCOSS) do, including sharing examples of safety issues to learn from.

For more information contact **events@structural-safety.org**>.

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