

# CROSS

Confidential Reporting on Structural Safety

## Newsletter 58 | April 2020

### Editorial

All thoughts about safety are concentrated on the COVID-19 epidemic and the threats brought to the world. It is dangerous and debilitating at the front line of medical care and we must applaud and thank those who are protecting our lives, sometimes at the cost of their own.

In risk terms this overwhelms everything, and the implications would have been unimaginable a few weeks ago except to a few experts who know the dreadful power of pandemics. Some had warned for years of upcoming threats from diseases originating in remote corners of the animal world and jumping species. There was preparedness in many countries but as events have unfolded the lack of awareness and of sufficiently robust contingency planning has become evident.

Many lessons will emerge, and it will be incumbent on national and international leaders to put in place the necessary actions to learn from them. These will be medical, financial, and above all societal, so that the world can recover and is better prepared for the inevitable next pandemic. Only the date will be unknown. To ensure safety, the advice of experts is critical and must be adopted.

In the construction and building management sectors there will be lessons to learn too. See the information box on page 2. In these circumstances what are the new risks, be they to workers, operatives, building managers or occupiers? We must design and pre-plan for structural robustness whatever the world brings to us.

At CROSS we look at building safety and by disseminating lessons learned from reporters and our expert panel, encourage industry to take steps to prevent future failures and collapses. Lessons are there to be learned, and whilst the context is small by comparison, the safety of our buildings and built assets is crucial to society.

Many in the construction industry are fearful about their jobs, their health, and the continuity of their companies, so structural safety will not be high on their agendas. Nevertheless, it would be even more distressing if there were to be building failures as a consequence of inaction. Please continue to make your reports: CROSS is 'working from home', and just as busy and focussed as ever.

Following the Hackitt Report and the proposed new Building Safety legislation, a project was started in January for MHCLG (Ministry of Housing Communities and Local Government) to enhance CROSS and develop a new confidential reporting system for fire safety. Thanks are due to those who responded to a survey about this and the results are encouraging and helpful. Work will continue for the next 12 months in addition to our usual activities and updates will be given in the Newsletters.

The reports in this edition fall into the categories of either inadequate design methods, or inadequate supervision and control on site, and there are lessons to be learned for all.

*Alastair Somers*

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### 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

### CROSS

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### 908: Failure of RAAC planks in schools

#### **R** REPORT

Having read the May 2019 **SCOSS Alert on Failure of RAAC Planks**>, a structural engineer has contacted CROSS to share their experience of working on projects with Reinforced Autoclaved Aerated Concrete planks. In 2017, they were asked to investigate an RAAC roof which had collapsed in a school. Luckily, there was no one in the classroom at the time of the collapse.

According to the reporter, the cause of the collapse was a shear failure due to inadequate bearing following some structural alterations made by the school. The failure was triggered by outfall gutters becoming blocked which allowed ponding of water on the roof to quickly build up during a storm. The reporter carried out a full structural survey of the school and found numerous other signs of progressing defects similar to those highlighted in the SCOSS Alert.

In 2019, the reporter was asked to investigate the partial failure of an RAAC plank at another school. Temporary props were installed to prevent collapse of the RAAC planks. The reporter carried out a full structural survey of the school and again found numerous defects in the planks, which were mainly related to historic roof leaks which caused the reinforcement in the planks to corrode and thus lose bond with the concrete.

The reporter is now frequently encountering RAAC planks in school roofs and their experience suggests that these planks are becoming more defective with time. They have also found that many schools do not even know that their roofs are constructed using RAAC planks and are therefore not aware of the risks.

#### **C** COMMENTS

In a departure from our usual practice, this report was published in advance of the Newsletter due to the possible urgency of the issues.

It is one of several that was received following the publication of the **SCOSS Alert on Failure of RAAC Planks**> in May 2019. These confirm that there are considerable areas of roofing consisting of RAAC planks in use in public buildings in the UK. It appears that not all of these have been identified, so structural engineers and building professionals need to be aware of the situation and, when possible, check for RAAC on large flat roofs built around the 1960s-80s.

The Local Government Association, the Department of Health and Social Care, and the Department for Education have advised owners to check their premises and make inspections to ensure that they know what they own, and if RAAC is suspected, to have structural assessments made.

It is not surprising that schools do not know the composition of the structures in their buildings. By way of explanation, a description of RAAC is shown below.

An interest group has been set up to monitor the situation and to recommend further research into the extent and nature of the problems. The group will be interested to hear of further experiences and anyone looking for more information should contact [structures@structural-safety.org](mailto:structures@structural-safety.org).



**SUBMIT REPORT**

**SUBMIT FEEDBACK**

#### **I** INFORMATION

#### **CROSS learning from lockdown: structural safety hazards from COVID-19**

CROSS would welcome your reports on new structural safety hazards arising from these or other consequences of the COVID-19 pandemic; your reports will help us learn for the future.

Safety hazards might be in the present during lockdown, be in the future as we hopefully get back to normal afterwards or become embedded in the built fabric and give problems in years to come. What are you finding that we should learn from as a result of:

- concerns about designs, checks or quality assurance;
- works suspended, sites closed, structures left part-built;
- revised work methods or changed supervision practice that have knock-on effects to structural safety;
- consequences of 24/7 higher occupation of residential buildings during lockdown;
- consequences of vacancy of non-residential buildings, or non-use of other structural assets;
- postponement or curtailing of safety or inspections or maintenance activity;
- loss of look, see, touch, feel - the intuitive engagement with hazard, risk and early warning signs;
- other responses to this terrible crisis.

**Submit CROSS report>**

#### **I** INFORMATION

##### **What is RAAC?**

Autoclaved aerated concrete (AAC) is different from normal dense concrete. It has no coarse aggregate, and is made in factories using fine aggregate, chemicals to create gas bubbles, and heat to cure the compound. It is relatively weak with a low capacity for developing bond with embedded reinforcement.

When reinforced (Reinforced AAC: RAAC) to form structural units, the protection of the reinforcement against corrosion is provided by a bituminous or a cement latex coating, which is applied to the reinforcement prior to casting the planks. The reinforcement mesh is then introduced into the formwork and the liquid AAC mix added.

## 904: Structural issues with cladding

### **(R) REPORT**

A reporter who investigates cladding failures says that they are normally asked to establish the cause of the failure and comment on the roles of the designers and contractors. Issues they have encountered include:

- 1. Design of movement joints:** the designer failing to adequately consider the combined effect of construction tolerances with thermal and moisture movements. This can cause the following design issues which may result in cladding failure:
  - a.** failure to provide movement joints, causing materials and fixings to become overstressed;
  - b.** insufficient allowances at movement joints causing either the joints to close and impose stresses on the cladding and fixings, or to open excessively causing restraint fixings to disengage.
- 2. Tolerances for cladding hooks:** when cladding fixings rely on a series of 'hooks' attached to the structure onto which the cladding is hung, it is vital that the hooks and the corresponding fixing points on the cladding panel are aligned so that they are properly attached.

The reporter has encountered cases where the required attachment was not properly achieved. They advise that hook systems like this should either be fully manufactured off-site, or if installed on site, should be done using templates to ensure the correct location of the fixings. In both cases, they say that a rigorous checking procedure should be in place.

- 3. Interaction between cladding and supporting structure:** the interaction between cladding panels and the supporting structure is sometimes not well understood, says the reporter.

For example, if stiff cladding panels, such as precast concrete, are fixed to the edge of a concrete floor slab which spans parallel to the panels, the panels may act compositely with the slab when it is under loading if the fixings provide restraint against vertical movement. This can overload the fixings and cause them to fail, causing panels to fall off in extreme circumstances.

To overcome this issue, and as recommended in relevant guidance such as **BS 8297:2017 (Code of practice for Design and installation of non-loadbearing precast concrete cladding)**>, the support system for panels can be positioned at two points only so that the panel does not act compositely with the floor slab and provides a predictable distribution of loads onto the supporting structure.

- 4. Fixings for heavy cladding panels:** the attachment of fixings into heavy panels is sometime inadequate.

An example the reporter encountered was when fixings for heavy concrete cladding panels consisted of cast-in anchors located very close to the top of the panels, resulting in no reinforcement between the cast-in anchors and the top of the panel in some cases. This issue can arise if the reinforcement for the panel is designed by a structural engineer, and then subsequently, the fixings for the panel are designed separately by the precast supplier, without review by the structural engineer who originally designed the reinforcement.

- 5. Design of whole cladding system:** the reporter says that every element of the cladding system should be designed, all the way back to the structural frame.

An example of where this might get overlooked is in the design of bespoke metal cladding systems. Although the cladding itself may be robust, the fixings can rely on lightweight aluminium sections concealed within the cladding and connected to the cladding using stainless steel screws.

The reporter has come across cases where the lightweight aluminium sections were substantially under-designed, which can cause the fixings to fail and cladding panels to fall. They recommend that the aluminium sections, along with the screws, are checked to ensure that they can resist the applied loads.

### **I 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

**6. Design of details and interfaces:** an issue that can affect all types of cladding, but particularly bespoke systems, is a failure to fully design all the details and interfaces.

The reporter says that this can result in ad-hoc design being carried out by the installers on site without a full understanding of the engineering requirements. Such ad-hoc design is not reviewed by the original designer and is often not recorded on 'as-built' drawings.

**7. Copings on parapet walls:** an often overlooked element of a cladding system is the copings on the top of parapet walls. However, these are often subjected to the most severe wind loading on a building.

The reporter has encountered issues where the design of copings on parapet walls was left to a specialist sub-contractor who did not have the required competence to understand the required load resistance or the need to provide for thermal movements. The reporter recommends that the design of such elements should always be reviewed by the project's structural engineer.

**8. Shop signs:** although not strictly cladding, the reporter states that shop signs are often installed in an ad-hoc fashion without any engineering input. Such signs, which can weigh several hundred kilograms, can be inadequately fixed and/or subject to deterioration of the fixings due to the use of unsuitable materials, which can result in the signs falling from buildings.

### **C** COMMENTS

This is an interesting report highlighting a number of themes:

- The complexity in reality of what might seem relatively straight forward items.
- The need for industry feedback on real behaviour.
- The anticipation of modes of failure.
- As always, fixings are a vital component in any system.
- The need to assure that real installation matches anticipated design.
- The recurring theme of danger at the interfaces of responsibility.

The report highlights the trend for design being split into multiple packages and passed down the contractual chain with no one seemingly responsible for how the final

product performs. This has many similarities with report 911 both in terms of the risks associated with failure and the lack of design control.

Several recent cladding failures have illustrated concerns with:

- inadequate design;
- inadequate specification;
- inadequate / unsupervised installation leading to missing components or inadequate installation of fixings;
- failure of the fixings exacerbated by the use of hidden fixings which cannot be inspected, and
- inadequate assurance checks, where primary structure is given consideration, but secondary structural elements may be overlooked.

CROSS recommend that cladding design and installation is given the same degree of attention as the primary structure during both design and construction to improve safety, reliability and longevity. It is really important that a single entity (or chartered engineer) should have overall control of the design of the cladding system including its interfaces with the support structure and to assure the ability of the structure to support the applied loads.

### CROSS recommend that cladding design and installation is given the same degree of attention as the primary structure during both design and construction to improve safety, reliability and longevity

Where bespoke cladding systems are proposed, there are well established test procedures that can be used. See for example the work of **CWCT**> (Centre for Window and Cladding Technology). These test wind, water and impact loads and can help to flush out problems even if the principles are similar to cladding used on other projects. Other sources of information are the **CFA**> (Construction Fixings Association) and **BS8539:2012**> (Code of practice for the selection and installation of post-installed anchors in concrete and masonry).

Fixings for signs can be safety critical. For example, there was a fatality in 2015 after a sign fell on to a shop worker. **A report by the HSE**> said an original "much lighter" sign had been fixed to the building prior to 1980 using woodscrews and a vertical stud. It is believed the sign was made unsafe by the addition "of a larger and much heavier sign", also installed prior to 1980, but the installers relied on the fixings of the original sign.



**SUBMIT REPORT**

**SUBMIT FEEDBACK**

### **N** NEWS

#### CROSS-US Newsletter 1

CROSS-US published their first Newsletter in March 2020.

[Download CROSS-US Newsletter](#)>

You can sign-up to the CROSS-US mailing list for email updates from CROSS-US at the link below.

[Sign-up to the CROSS-US mailing list](#)>

### **N** NEWS

#### CROSS-US Director recognised in ENR's Top 25 Newsmakers 2019

Glenn Bell, SEI President and Co-Director of CROSS-US, has been recognised in the Engineering News-Record's Top 25 Newsmakers 2019 for his service to the construction industry and the public.

[View Engineering News-Record article](#)>



## 882: Post-tensioned slab failure

### REPORT

A reporter has shared some key points from an investigation after the end of a slab burst during a cable tensioning operation. An operative hit by the debris sustained relatively minor injuries, however the consequences could have been much worse. The 'live' end of the cable being tensioned moved as the fixing in the concrete failed, exploding the slab in an area around 1.5x1.5m.

There was a range of potential causal factors including over stressing of the cable, concrete strength and structural design. The contractor, the post-tensioning (PT) installer and the PT designer concluded that localised under-strength concrete was used, due to the method adopted on site of grouting the mobile pump line and discharging into the permanent works.

It is thought that this is a rare occurrence, although a similar incident had occurred on a previous project when heavy rain on the day of a pour caused a local weakness in concrete and failure at the end of a cable.

### The contractor, the post-tensioning installer and the post-tensioning designer concluded that localised under-strength concrete was used



Figure 1  
Post-tensioned slab failure

### Lessons learned

**a) Concrete concerns:** The fabric of the slab was destroyed near a tendon 'block' arrangement which was only tensioned once the concrete had reached a strength of 25N. Procedures were in place and were used to verify the strength of the concrete from both the concrete frame contractor and PT contractors' perspectives, thus the concrete should not have failed.

*Outcome: grout in pump lines must not be discharged into the slab area and must not form part of the permanent works.*

**b) Duty of care/informal reservations:** The PT contractor had suggested that despite the achieved 25N strength test results, that they have previously verbally informed the concrete frame contractors' supervision staff of their concerns regarding the concrete. Anecdotal suggestions after an incident is normal, but in case there are serious issues, concerns should be formalised at the time.

*Outcome: PT contractor is to be encouraged to properly state their concerns in writing on programme, structure or safety.*

**c) Bursting concern:** Following the incident, the subsequent risk potential was considered, and the robust segregation area advocated in the PT contractor's risk assessment was implemented and additional coverings as 'Blast Mats' added (i.e. plywood or tarpaulin).

*Outcome: PT contractor was asked to review their RAMS accordingly.*

**d) Concrete quality assurance:** Concrete frame contractor to revise concrete method statement to include a statement on grout discharge. The PT contractor is to include a statement within their PT method statement to emphasise the importance of good compaction and ensuring homogenous concrete.

*Outcome: Quality assurance checks to include ensuring grout in pump lines and heavy rain is not incorporated into the permanent concrete works, especially at the start of the pour.*

**e) Awareness:** Refresher tool-box talks to be conducted for the concrete gang (and on other concrete frame contractor projects) as recommended by the PT contractor.

### COMMENTS

This incident highlights a strong justification for CROSS reports. It appears that something serious happened without any one party being obviously negligent. Lessons were learned by the parties involved, but disseminating the danger and precautionary measures more widely ought to be highly valuable.

The reporter, and the organisations concerned, are to be complimented on releasing their findings for the benefit of others who might be faced with similar situations.



SUBMIT REPORT



SUBMIT FEEDBACK

### NEWS

#### CROSS-AUS Newsletter 3

CROSS-AUS published their third Newsletter in February 2020.

[Download CROSS-AUS Newsletter>](#)

You can sign-up to the CROSS-AUS mailing list for email updates from CROSS-AUS at the link below.

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## 886: Unconservative design of flat slab

### REPORT

A reporter's organisation recently came across a design/modelling problem which gave highly unconservative analysis results, causing an under-designed RC slab to be constructed within a large domestic property.

A loadbearing blockwork wall, supported on a transfer slab, was mistakenly modelled as a concrete shell element within a 3D finite element (FE) package, as opposed to a more realistic approach of modelling such walls as a series of pin ended columns.

When the transfer slab was exported to a 2D FE package for reinforcement and deflection checks, the 3D concrete wall element was converted to a line element of equivalent stiffness and incorporated within the 2D FE analysis.

**A loadbearing blockwork wall, supported on a transfer slab, was mistakenly modelled as a concrete shell element within a 3D finite element package, as opposed to a more realistic approach of modelling such walls as a series of pin ended columns**

The result of this was that the transfer slab was artificially stiffened by the line element, which was effectively acting as a very stiff beam with a depth equivalent to the height of the wall over. As such, both the long-term deflection prediction and the reinforcement demand was significantly underestimated.

The already constructed slab was found to have around 50% of the necessary ultimate limit state design reinforcement and was about to receive a 75mm screed. Once the modelling error was discovered following observed excessive cracking to the supported masonry wall, temporary propping was installed.

A permanent strengthening solution was developed by way of a heavy steel transfer beam installed below the wall, although ceilings had to be removed and services diverted in order to achieve this.

To avoid such an error, when creating or checking a 3D FE model, it needs to be ensured that any loadbearing masonry wall that is transferred onto a slab below, or that is not vertically continuous down to foundation, is modelled as a series of individual pin ended columns. This ensures that they act in the vertical loadbearing direction only, and thus cannot act as a deep beam. 'Wall' shell elements within a 3D FE model should only be used where a vertically continuous RC concrete wall is proposed, as otherwise they can artificially stiffen the structure by acting as deep beams.

The design checker should also ensure that they see an 'extruded' and annotated view of the 2D model, in order to verify that the structure has been modelled correctly.

### COMMENTS

There has been much disquiet expressed in engineering circles about the improper use of (or over reliance on) computer modelling with potential for results to be divorced from reality. This report is a classic illustration of the kind of problems that might arise. Safety demands that all model outputs are subjected to a simplified sanity check which appears not to have happened.

**Safety demands that all model outputs are subjected to a simplified sanity check which appears not to have happened**

Beyond that, the description of this model suggests an inappropriate level of refinement for the essentially simple task of designing an RC slab supporting a wall. If, however the slab in question is complex with, for example, significant openings, then accurate modelling is all the more important.

There were a number of opportunities to discover this mistake. For example, as the wall was in the model, a very quick review of the stresses in the wall would have highlighted that they were inappropriate for a masonry wall. This highlights the need to check the whole model during the design not just the element of immediate interest.

Similar errors can occur when concrete slabs are constructed from precast planks but modelled as a solid diaphragm leading to an underestimate in the loading to the supporting beams; a check of bending in the slab perpendicular to the span would have highlighted this. It is disturbing that such a slab can be detailed and constructed with only 50% of the required rebar without anyone in the office or on site thinking it looked odd.

CROSS-US recently published their first **Newsletter** > and here is an extract from the comments on a historic failure; the **Hartford Coliseum roof collapse** >:

*Questions regarding the sufficiency of computer modelling, the adequacy of peer review, and the role of the structural engineer in the field have been raised recently in the FIU bridge collapse. This will be the topic of an upcoming CROSS-US report. In the UK, the Standing Committee on Structural Safety (SCOSS) and CROSS have had a long-standing policy of endorsing third party checks for key structures. The rationale is to assure public safety. In 2016, SCOSS published a paper **Reflective thinking** > which looked at over-reliance on computer modelling and posed a set of questions for the designer:*

- Is the model capable of satisfying the requirements? (the validation question)
- Is the model the most appropriate in the context?
- Has the software been validated and verified?
- Has the model been correctly implemented? (the verification question)

This is an early indication of the value of CROSS sharing experiences between countries by linking the Hartford collapse, the FIU bridge collapse, this report, and other CROSS reports on computer modelling failures. There is an overriding need in the construction industry to have sufficient checking by suitably qualified and experienced persons to uncover such serious errors.



SUBMIT REPORT



SUBMIT FEEDBACK

## 906: Missing punching shear reinforcement

### REPORT

A reviewer for a professional membership institution was concerned to note that two candidates they recently interviewed reported an experience where, as a structural engineer monitoring the progress of their projects on site, they had observed the omission of design punching shear reinforcement in a slab pour about to take place.

Given that these two candidates were from different companies with different project experiences, the reporter feels it is worth reporting this in case it is a trend. One of the candidates was particularly experienced having visited many sites and said that omission of punching shear reinforcement is a 'watch-it' item within their team.

### COMMENTS

Issues about shear reinforcement in slabs, particularly flat slabs, have been around for many years and were highlighted by the failure of the **Pipers Row Car Park**>. This multi-storey structure was built in 1965 and a 120-tonne section of the top floor collapsed during the night of 20th March 1997. An initial punching shear failure developed into a progressive collapse.

Designers should know that the critical connection on any flat slab is the shear resistance around its supports. Part of a structural engineer's skill set is to know what to look for and to create a structure that is capable of being strong enough even before starting calculations. These skills are only acquired by practice (under supervision).

However, as such reinforcement is a critical factor in the safety of flat slabs, the importance of it being in place should be known to constructors and supervisors.

Designers of flat slabs should make it their business to conduct site inspections, or have them conducted, before concreting.

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SUBMIT REPORT



SUBMIT FEEDBACK

### NEWS

#### US SEI Structures Congress 2020

The Structural Engineering Institute (SEI) Structures Congress 2020 took place as a virtual event on 07 April 2020. One of the special sessions was on CROSS-US, presented by Glenn Bell, Alastair Soane and Andy Herrmann.

You can view a recording of the entire event at the link below, with the CROSS-US session beginning at 1:15:45 into the video.

[Watch recording of Structures Congress 2020>](#)



● **Figure 2**  
**Pipers Row car park collapse**

**Attribution:** Jonathan Wood, *Pipers Row Car Park, Wolverhampton, Quantitative Study of the Causes of the Partial Collapse on 20th March 1997*

### 873: Propping of post-tensioned slabs

#### REPORT

When casting in-situ concrete slabs, they are typically propped and supported by the two floors below. For a concrete framed building a reporter was involved with, this was how the contractor constructed the floors. The slab was post-tensioned, and the contractor had left strips out in the slab to allow it to be post-tensioned. Once the slab had been tensioned, the small infill slab strips were to be cast.

During the construction at one level, the infill slab strip at the level below had not yet been poured. Therefore, the weight of the slab being cast, and the weight of the floor below was all being taken solely by the floor two levels below. Fortunately, this slab was designed for high superimposed and finishes loads. If this had not been the case, the slab could have failed, says the reporter.

Lessons learnt are that the contractor needs to ensure that post-tensioning strips are always cast and have achieved the required design strength if they are to be used to prop the slabs above.

#### COMMENTS

The broader lesson is the wider one of the interactions between design and construction. In reality, the two phases are intimately linked, and it is not at all uncommon for critical design cases to occur during the construction phase. It is therefore vital that the design and construction teams co-operate to assure that designs can be safely built and thereafter be safe in service. Once a safe method of construction has been designed, it is essential that this method of construction is followed.

In this case, it was fortunate that the lower slab was strong enough to withstand the wrong sequence - this would not always be the case.

**It is not at all uncommon for critical design cases to occur during the construction phase**

#### INFORMATION

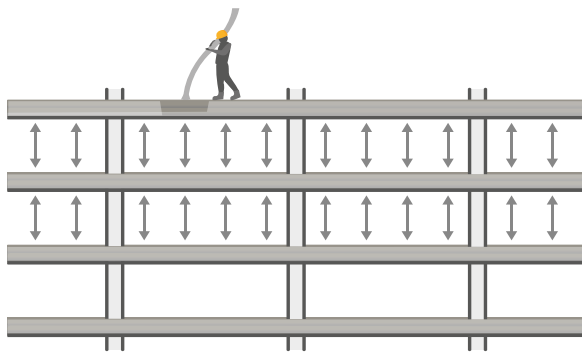
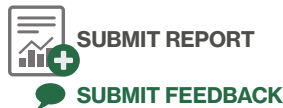
##### CROSS report 866 Portal frame design and fabrication - revised comments

The CROSS Panel comments on report 866 Portal frame design and fabrication were revised following feedback received from a reader.

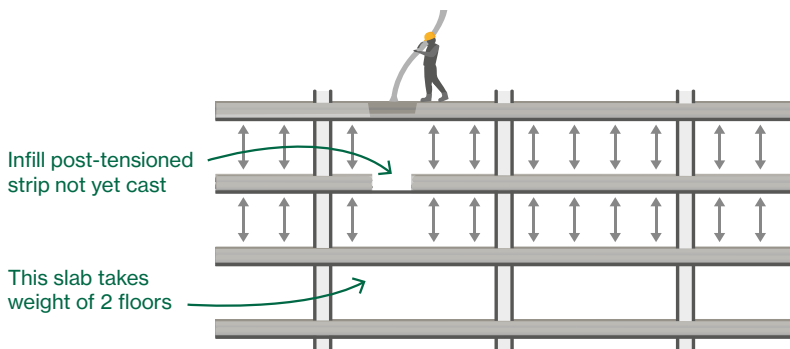
[View report 866 Portal frame design and fabrication >](#)

All feedback received can be viewed on the Structural-Safety website.

[View feedback page >](#)



**Normal good practice - load spread over 2 floors**



**Propping as installed - lower floor taking all of the load**

● **Figure 3**  
Propping of post-tensioned slabs



## 911: Suspended ceiling replacement in high rise block

### REPORT

A reporter is involved with replacing MDF ceilings (15mm thick heavy panels) on a 30+ storey UK tower block. The work was triggered by fears following a few loose panel falls, in one case resulting in a minor injury. What emerges says the reporter is:

1. Ceiling detailed design is typically a contractor/installer designed portion (CDP).
2. Typical generic manufacturers' details need modifying to suit a given building.
3. There is effectively no structural engineer involvement, with the architect being expected to define the characteristics and the sub-contractor expected to complete the design and installation. The checking duties of the architect of the CDP are unclear.
4. Services access panels can be removed and not reinstalled properly (there can be landlord's common area services and leaseholder flat owners who have different companies doing maintenance).

When the reporter has queried in the past with quantity surveyors about what they need to do with CDPs, for example CDP for steel connection design, they are told to do nothing, seemingly because when a CDP is identified in a Joint Contracts Tribunal (JCT) contract, it is a way of packaging up design development/cost/risk. The JCT/CDP seems to ignore a designer's legal duties defined in their agreement.

### COMMENTS

Ceilings may appear to be minor items that can just be delegated to 'installation'. However, CROSS has published numerous reports of heavy ceiling cascade failures which represent a credible safety hazard. To find these go to the [www.structural-safety.org](http://www.structural-safety.org) website and enter "ceiling" in the Quick search Keyword box. Over forty reports will be shown.

There is generic hazard with any suspended structure. The SCOSS Alert [Tension systems and post-drilled fixings](#) may

be consulted for advice on fixings. Other sources of information are the [CFA](#) (Construction Fixings Association) and [BS8539:2012](#) (Code of practice for the selection and installation of post-installed anchors in concrete and masonry).

This report has similarities with cladding report 904 when design is passed down the chain, standard designs may be modified on site, and no one is responsible to check that the final solution meets the required standards.



SUBMIT REPORT



SUBMIT FEEDBACK

## 915: Crane outrigger loads underestimated due to misuse of software

### REPORT

A reporter would like to raise awareness of an issue they have experienced with incorrect outrigger loads for mobile cranes. They work as an in-house temporary works design engineer for a main contractor and regularly deal with designing the foundations for crane outriggers. This requires knowing the accurate loads in the outriggers to check the ground and any surrounding structures or slopes.

For a particular crane lift, computer calculations had been provided to give the outrigger loads but these were not for the crane boom in the worst-case position and had to be corrected. With large mobile cranes with different rig configurations, it may not be possible to adequately check the outrigger loads without in-depth working knowledge of the crane.

This is not an isolated case, continues the reporter, and due to incorrect use of software, it seems to be becoming more common. The consequence of being supplied with the incorrect outrigger loads can be severe. Lifts regularly take place close to retaining walls, tunnels and underground services. The reporter feels that this issue needs addressing before it becomes a contributing factor in a serious incident.

### COMMENTS

There are some similarities between this report and report 904. In both cases, there are significant structural engineering issues in design areas that will be unfamiliar to many engineers (no matter how much general experience they have). Not everyone will be familiar enough with the operation of mobile cranes to be able to identify configurations that give worst case outrigger loads.

A lesson is to beware when taking on anything novel and indeed this is integral with the ethics codes of professional institutions and the [Royal Academy of Engineering's Statement of Ethical Principles](#), one of which is "perform services only in areas of current competence".

The risk associated with a crane collapse may be to adjacent infrastructure with disproportionate consequences, such as equipment falling onto a railway track in the path of a train. In the UK, this was examined in the 2011 HSE report [Preventing catastrophic events in construction](#). In December 2018, the Crane Interest Group

(CIG) published [CPA 1801 Good Practice Guide - Requirements for Mobile Cranes Alongside Railways Controlled by Network Rail](#).

It is sensible for all crane bases to be checked and in the first instance basic hand calculations and rule-of-thumb methods will give an indication of foundation loads, including outrigger loads. As always, key operations on site need to be under the control of qualified competent staff who work to procedures provided by crane suppliers. Correct procedures for erection and dismantling must be followed.



SUBMIT REPORT



SUBMIT FEEDBACK

## 889: Dangerous substitution of lintels on domestic projects

### REPORT

New lintels were being installed as part of a home extension project. The structural engineer had specified the concrete lintels. However, during construction, the contractor informed the engineer of their intent to substitute the specified lintel with an alternative lintel from the same supplier.

It was the contractor's understanding that the structural properties of the two lintels were identical because the geometry was identical. The engineer disputed this claim and used span/load tables to show the contractor that, for the required span, the capacity of the alternative lintel was approximately 0.7 times the capacity of the specified lintel. The contractor admitted that they were unaware of this and had been substituting these lintels for several years on the recommendation of the supplier.

The engineer later learned that the supplier spray painted the end of one type of lintel to allow it to be identified from the other type, but the reporter points out that this does not assist with identification of the type of lintel after it has been installed.

This situation has left the reporter concerned because:

1. The contractor and their supplier's lack of understanding means that several understrength lintels have been installed on other projects, eroding safety factors and significantly increasing the risk of failure;
2. The lack of identifying marks on the lintels means that it is not possible to determine the capacity of proprietary lintels post-installation, and
3. The fact that the contractor could install understrength lintels for several years without challenge highlights a systematic error in the control of product substitutions in domestic projects.

**The contractor and their supplier's lack of understanding means that several understrength lintels have been installed on other projects, eroding safety factors and significantly increasing the risk of failure**

### COMMENTS

The topic of inappropriate substitution has been raised in other published reports. A common case is substitution without reference to the design team, which runs the risk of undermining design intent. If anything went wrong, and no reference to the design team had been made, the person or organisation making the change might be liable.

No changes should be made without design team verification. In this case, lintels might be considered minor items, but in any wider study of disasters, it will be found that 'unauthorised design change' is a common heading for disaster cause.

A second issue is the very common one of being able to verify that what was built matches design intent. Sometimes this cannot be done because items are covered up. Sometimes without markings (or paperwork), verification is equally impossible. All this points to the need for a proper quality assurance and inspection regime.



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 online 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](mailto:events@structural-safety.org).

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