CROSS UK
COLLABORATIVE REPORTING FOR SAFER STRUCTURES

The Institution of Structural Engineers

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The Institution of Fire Engineers

CROSS Newsletter

CROSS-UK Newsletter 61 | **March 2021**

Collaborative Reporting for Safer Structures (CROSS)

CROSS for fire safety

The risk of collapse of multi-storey CLT buildings during a fire | Report ID 966

Share knowledge to help create a safer built environment

Editorial

Since the last Newsletter in October 2020 there have been major updates to CROSS and this edition hails the launch of a new era. An extended system for structural safety, a new system for fire safety, a new website, improved layout for reports, easier method for reporting, and a fresh approach to everything.

We have a new name, Collaborative Reporting for Safer Structures (CROSS), to embrace our wider ambitions.

For many this will be their first Newsletter, whilst for others it will be their sixty first since the introduction of the system in 2005. Much has changed and safety in our environment has assumed much greater significance as a result of increases in concern from the public, from Governments, and from within the professions. The consequences of the dreadful Grenfell Tower fire have been felt far and wide and are the catalyst for changes to the culture of the construction industry.

The Hackitt report recommended that CROSS be expanded and funding to do so was provided by MHCLG (Ministry of Housing, Communities and Local Government). Early in 2020 research was conducted to help shape our future. It was found that we are viewed as trusted, independent and expert in our advice; all good characteristics, but it was felt that we could have more influence if we were more widely known.

The CROSS team is led by Paul Mc Nulty who joined us in 2017. Over the past 18 months has been responsible for the development of the new system and today's launch. We are most grateful for his skills, commitment, exceptionally hard work and the contributions of those in his team.

We have been talking to leaders in the fire community for a long time and with the new funding there came a new impetus. Neil Gibbins joined the team and as a previous CEO of the IFE (Institution of Fire Engineers) he has brought energy, enthusiasm and knowledge, as well as a host of contacts within the fire community. The result is that as of now CROSS is also seeking reports concerning fire safety and will be providing Expert Panel comments for these, as we do for structural safety reports.

There is more detail on the changes in this Newsletter and further information is provided on the new CROSS website **www.cross-safety.org/uk>**. There are two structural safety reports in this Newsletter and two fire safety reports; one on CLT (Cross Laminated Timber) buildings and the other on defects found during inspections on hospitals.

After 16 years as Director, firstly of CROSS from 2005, and then of Structural-Safety from 2012, I am now stepping aside to become a consultant for CROSS.

Alastair Soane

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Reporting to CROSS

Your report will make a difference. It will help us to create positive change and improve safety.

Find out more >

Visit:
www.cross-safety.org/uk

Email:
team.uk@cross-safety.org

Collaborative Reporting for Safer Structures (CROSS)

News

CROSS helps professionals to make structures safer. We do this by publishing safety information based on the reports we receive and information in the public domain.

Our secure and confidential safety reporting system allows professionals to share their experiences to help others.

Dame Judith Hackitt's recommendation

We were previously known as Structural-Safety, which had two parts; the Standing Committee on Structural Safety (SCOSS) and Confidential Reporting on Structural Safety (CROSS). Structural-Safety, SCOSS and CROSS are now integrated under our new name, Collaborative Reporting for Safer Structures (CROSS). The new name reflects the integrated way in which professionals collaborate for a common purpose.

As part of our mission to make structures safer, we have broadened the remit of CROSS-UK to include fire safety. This is a consequence of the Grenfell Tower fire in 2017. It has been driven by Dame Judith Hackitt's appointment by Government to carry out an **Independent Review of Building Regulations and Fire Safety>**.

Evidence was given by CROSS-UK based on reports received through our confidential safety reporting system that illustrated the depth and extent of safety issues within the building industry. This led to recommendation 1.4c in the final report which stated:

'…the current CROSS scheme should be extended and strengthened to cover all engineering safety concerns…'

Our background in structural safety

SCOSS was established by the Institution of Structural Engineers (IStructE) and the Institution of Civil Engineers (ICE) in 1976.

The main function of SCOSS was to identify in advance trends and developments which might contribute to an increased risk to structural safety. General findings were published periodically, along with publications on specific matters of interest. More than one hundred topics have been closely studied over the last 45 years. Many of these by their nature are fundamental and ongoing issues.

Voluntary safety reporting for the built environment

In 2005, SCOSS implemented a system for the collation of data on matters of concern relating to structural safety. The system was named Confidential Reporting on Structural Safety (CROSS). It was based on the success of confidential reporting in the aviation industry.

CROSS allowed professionals to confidentially share their experiences to help others. It aimed to improve safety by publishing information which would not otherwise get in to the public domain.

To date, CROSS has received over 1,000 safety reports on topics ranging from issues with domestic buildings to major structural collapses. Each report contains information which the industry can learn from to make structures safer.

The expansion of CROSS-UK in to fire safety

Conversations with the fire safety community as a natural partner to the structural safety community started a decade ago and relationships have been evolving ever since.

Each report contains information which the industry can learn from to make structures safer

Prior to our expansion in to fire safety, CROSS-UK received a number of reports related to fire safety. These were generally in the space where fire safety and structural safety come together.

You can read more about the new developments for CROSS and fire safety in the next article.

Reporting to CROSS

Our secure and confidential safety reporting system allows professionals to share their experiences to help others.

CROSS-UK welcomes reports about fire safety and structural safety issues related to buildings and other structures in the built environment. Reports should aim to include information that will help others to learn from the safety issue identified. Reports typically relate to concerns, near misses or incidents.

Our confidential reporting system can be used by professionals who work with buildings and other structures. This includes anyone with an interest in, or responsibility for, fire safety or structural safety.

If you would like to know more about **reporting to CROSS>**, we have further guidance on our website.

Benefits of safety reporting

The aim of reporting to CROSS is to make structures safer and ultimately to save lives and reduce injuries. Safety reporting helps to achieve this by:

- **Promoting a culture change:** to encourage professionals to identify and report safety issues that occur throughout a structure's life cycle, including during design, construction, occupation or operation, demolition and reuse
- **Sharing lessons learned:** to identify key lessons to be learned from safety reports to help professionals to make structures safer
- **Identifying pre-cursors:** to identify and provide an opportunity to address pre-cursors which might result in a risk to life safety in similar circumstances if not addressed
- **Identifying shortfalls:** to identify and provide an opportunity to address shortfalls in the design, construction, occupation or operation, demolition and reuse stages
- **Improving competency:** using published safety reports from CROSS as training and learning will form a key part of increasing the competency levels of all professionals
- **Supporting regulatory activities:** information from analyses of the reports can be used for enforcement and wider regulatory activities such as planning future activity, publishing guidance and providing training and advice
- **Supporting industry activities:** safety reports can be used by industry bodies as a learning resource for their members. Trends identified from reports can be used by industry to publish guidance and provide training.
- **Assisting with horizon scanning:** culture change and improved competency will help professionals and others to look ahead and predict future safety risks which have not yet been identified as likely. These include low probability but high consequence events.

> **The aim of reporting to CROSS is to make structures safer and ultimately to save lives and reduce injuries**

Expert Panel Comments

Expert Panels are at the heart of what we do. The Members are all volunteers.

Expert Panels comment on reports we receive. They use their experience to help you understand what can be learned from the reports. Where possible, they aim to identify the underlying causes and make reference to other publications that those reading the report can access and use. Blame is never apportioned. The aim is to enable lessons to be learned so that similar situations can be avoided.

> **Expert Panels comment on reports we receive. They use their experience to help you understand what can be learned from the reports.**

The Expert Panels have a number of other roles, including maintaining a continuing review of matters affecting safety in the built environment and helping to write other safety material for CROSS.

CROSS-UK has two Expert Panels, one for fire safety and one for structural safety. You can find out more about the **CROSS Expert Panels>** on our website.

How to become part of the CROSS community

We want all professionals in the built environment to be part of our community. Here are some practical ways that you can get involved:

- **Share safety information for others to learn from:** you can do this by using our secure and confidential reporting system. Professionals who work with buildings and other structures can use our reporting system. You can find out more on our website.
- **Use the information on our website to make structures safer:** here are some practical ways that you can use the information:
  - As part of your continuous learning and development
  - Improve your knowledge of safety for your area of work
  - Keep up to date with emerging safety issues
  - Find out more about best practice
  - Share it with your team and others
- **Get in touch with us if you would like to collaborate:** we are always interested in exploring opportunities to work with others to make structures safer
- Encourage others to get involved with CROSS

CROSS for fire safety

News

Neil Gibbins discusses CROSS's expansion in to fire safety and the benefits that this will bring to the fire safety sector.

The Grenfell Tower fire

In December 2017, just six months after the Grenfell Tower fire, Dame Judith Hackitt produced her **interim report>**. The themes and issues identified continue through to the final report, with all the recommendations being accepted by the Government. They are being addressed through various parliamentary and other processes.

Taking one paragraph from any document risks losing the context but this statement stands very well on its own. I feel it captures the essence of what Dame Judith found:

'The work of the review to date has found that the current regulatory system for ensuring fire safety in high-rise and complex buildings is not fit for purpose. This applies throughout the life cycle of a building, both during construction and occupation, and is a problem connected both to the culture of the construction industry and the effectiveness of the regulators.'

Around the time of the publication of the interim report, I was invited to join a gathering of people chosen to help identify solutions to the issues identified.

The meeting was addressed by the then Home Secretary, Amber Rudd. I will never forget her saying these words:

'People in our country must never again be faced with the decision to either die from fire in their flat or jump.'

Like many who have been at the sharp end in a fire situation, I could too easily put myself into that space. My more recent experiences in strategic and political circles made me think that such strong words from the Home Secretary confirmed that the Government really got it.

She so clearly articulated the horror that should not happen to people in our care. She recognised that the system was broken.

The beginning of CROSS for fire safety

It was also around this time when I first met Alastair Soane of CROSS. In my role as technical advisor to the Institution of Fire Engineers, Alastair approached me to open a discussion about CROSS. Dame Judith subsequently went on to make a distinct recommendation that CROSS should be expanded.

CROSS was already well embedded in the structural engineering profession. With little explanation it became clearly apparent that CROSS is more than a system to receive confidential safety reports.

The full background to the creation of CROSS, modelled on the US aviation safety reporting system, can be found elsewhere. The pertinent point here is that it is a key piece of a jigsaw that describes a good culture. Culture is something that Dame Judith pointed towards, a small word but so pertinent when considering how to develop an effective building safety system.

How the fire safety sector can benefit from CROSS

The fire safety sector has nothing similar to CROSS. The UK approach to fire safety over the last forty years has changed quite dramatically. It has gone from being almost totally owned and managed in a prescriptive manner by the fire brigades to a much more diverse, goal based, self-compliant and complex process.

In that period the bodies responsible for providing fire safe buildings, the people in the system and the materials used have changed dramatically. There has been little in place to bring them all together to look at the efficacy of the whole system. The expansion of CROSS is a key step that will support fire sector learning, providing a route for professionals to safely share lessons that need to be learned and to provide some oversight of the health of the fire safety system.

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In terms of the building life cycle, fire has to be considered at design, construction and occupation stages. The ownership and responsibility for compliance can change at each step.

The regulatory regimes for design, construction, materials and management can sit with different bodies, different regulators and under different government departments. Institutions central to the fire sector for decades have been changed or

lost. Examples include the Fire Services College, Her Majesty's Inspector of Fire Services and the Federation of British Fire Organisations to name but a few.

Throughout this period, fire deaths have fallen dramatically, probably one of the biggest improvements in headline performance of any sector. In broad terms, a reduction from around one thousand per year in the 70's and 80's to around 300 per year, across the UK.

Very few people will suffer a loss of a friend or relative from fire in their lifetime. However, Grenfell demonstrated that we must not become complacent. The hundreds of tall buildings clad in a similar manner could have led to similar disasters, with potentially more unidentified failings yet to be revealed. Dame Judith pointed out many areas that could be improved, one of them being that there is a need for a knowledge hub and I have learned that CROSS can be that hub.

> **Very few people will suffer a loss of a friend or relative from fire in their lifetime. However, Grenfell demonstrated that we must not become complacent.**

The broad role of CROSS

CROSS has a number of functions. It provides a route for professionals to tell others about something they are concerned about, or to share something they have learned. The information they give can be analysed by an Expert Panel that holds knowledge sufficient to identify the importance of the information and what lessons need to be learned.

The same Expert Panel sit back and look at the system and interpret how it is working and what needs to be done to keep it effective.

All of this is reliant on trust, integrity and a level of transparency. The right people doing the right thing at the right time. Building, developing and maintaining a good culture. CROSS is well established, trusted and thankfully open to sharing the learning about the process with their colleagues in the fire sector.

Over 1,000 reports have been submitted to CROSS and the analysis has fed into many CROSS Newsletters. Where appropriate, safety alerts have been disseminated to give a heads up, hopefully averting repeats that might lead to tragedies.

Engaging with the fire safety sector

Many of the structural safety reports submitted to CROSS are from members of the Institution of Structural Engineers (IStructE) or the Institution of Civil Engineers (ICE). Those who might learn from the reports are also primarily members of those same professional bodies. In contrast, the fire safety sector has many different potential sources for reports and outlets for learning.

The Institution of Fire Engineers (IFE) welcomed the chance to work with CROSS to provide a similar process for fire safety. After I had immersed myself in CROSS, to learn how it ticks, I was able to visit (pre COVID thankfully) many of the main influencers in the fire sector. I alerted them to the opportunity that was being created and got their feedback as to the need for CROSS and to identify any barriers. The response was overwhelming, yes, this is both needed and welcomed.

Fire safety as a natural partner to structural safety

It isn't a huge leap in some respects. CROSS has received reports relating to fire safety matters. These were generally in the space where fire safety and structural safety come together. Current issues around the use of mass timber for structural elements brings engineering challenges to both professions. However, there has been no formal interface to bring the two together in a safe space where concerns and ideas can be explored.

The formation of a CROSS-UK Fire Safety Expert Panel and regular planned events that bring them together with the CROSS-UK Structural Safety Expert Panel provides the opportunity to feed informed opinion into the building safety system.

Dr Peter Wilkinson and I have been engaged as Designated People for CROSS-UK to carry out the initial analysis and report collation. Peter is Technical Director for the IFE and is known and trusted across the sector; between us we have links to most of the pieces of the fire safety jigsaw.

A significant outcome of the relaunch of CROSS is the change of name. CROSS as an acronym is recognised, trusted and valued.

Our user research showed that the industry welcomed the acronym standing for Collaborative Reporting for Safer Structures as a way to both allow CROSS to broaden its remit in to fire safety and also to reflect the integrated way in which professionals will collaborate together for a common purpose.

The future for CROSS and building safety

The new CROSS has just been launched. For the founders of CROSS, it marks a step forward in assuring the future of a body that has done a great job to date. The success of CROSS in the UK has resulted in the establishment of CROSS in Australasia (CROSS-AUS) and the USA (CROSS-US) in the last few years.

The fire sector is re-shaping and recovering from the horror of the Grenfell Tower fire, and by supporting and becoming involved with CROSS, part of Dame Judith's culture jigsaw will slot into place.

The author, Neil Gibbins QFSM FIFireE, started his fire career as a firefighter in 1977. Whilst Deputy Chief Fire Officer for Devon and Somerset FRS he led the Chief Fire Officers Association work on fire protection before moving on to become President and then CEO of the Institution of Fire Engineers.

The risk of collapse of multi-storey CLT buildings during a fire

CROSS Safety Report Report ID: 966

A reporter presents concerns about the fire safety of multi-storey buildings comprised of cross-laminated timber (CLT) structures.

These concerns suggest to them an unacceptable risk of collapse in the event of an uncontrolled fire.

Key Learning Outcomes

For designers:

- Designs that propose the use of CLT as structural elements in multi-storey buildings should be reviewed by fire and structural engineers who have knowledge and understanding of the limitations and impact of the use of CLT

For engineers:

- It is good practice to keep up-to date with the latest research and guidance on fire safety design of CLT structures

For firefighters:

- Be aware of the consequences of fire involving a multi-storey building constructed using CLT

For civil and structural design engineers:

- Early consultation and liaising closely with fire engineers when CLT forms part of the structure can help with identifying potential risks
- Carrying out a systematic risk assessment for accidental loads, including fire, when using CLT in multi-storey buildings can also help to identify and remove risks
- The Structural Timber Association (STA) has recently published **Structural timber buildings fire safety in use guidance (Volume 6)>** which sets out credible pathways to demonstrating compliance with the requirements of the buildings regulations

R Full Report

This report highlights a growing trend in the industry regarding fire safety of buildings comprised of cross-laminated timber (CLT) structures. The concern particularly relates to multi-storey sleeping risk buildings in the UK. The design intent typically is to achieve 60 minutes fire resistance for structural load-bearing elements based on tables in Approved Document Part B (Part B).

Gaps in the contractor's knowledge

Buildings regulations and Approved Document B Compliance with this guidance does not automatically confer compliance with building regulations, which are the functionally based legislative requirements all new buildings must meet. Clause B3 (1) of Schedule 1 in the **building regulations>** requires that a building's '*stability will be maintained for a reasonable period*' in the event of a fire.

This, in the view of the reporter, is generally understood to mean that a structure should maintain its loadbearing capacity for as long as a fire could burn given available fuel sources; a fire should be able to develop, grow, naturally decay, and self-extinguish without intervention by the fire and rescue services, and without causing undue risk of collapse.

This is also the original basis for the longer fire resistance standards specified in Part B for multi-storey buildings and is referred to as design for burnout. Design for burnout is usually demonstrated by ensuring the structure meets a predefined period in a standardised fire test e.g. 60 or 90 minutes. However, the aim of the regulations for longer fire resistance durations is not to merely ensure that a test has been passed, but rather to ensure that a building's design is suitable to withstand burnout without collapse.

Is CLT self-extinguishing?

In buildings of non-combustible construction, such as steel and concrete, meeting the prescribed fire resistance in Part B is generally sufficient to ensure design for burn out.

However, for combustible construction it is also necessary to demonstrate that the structure itself would self-extinguish as the fire decays, continues the reporter. They go on to say that there is considerable academic research indicating that CLT does not reliably self-extinguish.

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Rather than benefiting from the build-up of insulating char, as would be expected from other types of structural timber, delamination (sometimes referred to as char fall-off) often occurs. This delamination process causes underlying CLT layers to become exposed and reignite during a fire. The result can be repeated episodes of charring, delamination, and reignition of underlayers; cyclical burning.

The reporter believes that as CLT does not reliably self-extinguish, one of the following methods should be used:

1. Demonstration of self-extinguishing behaviour should be provided for the particular CLT construction used, or

2. The CLT should be fully encapsulated in fire resistant plasterboard (or similar material) to limit the risk of it becoming involved in fire in the first place.

Fuel load from CLT

Part B guidance is based largely on risk associated with the anticipated fuel loading i.e. the combustible content expected in the building based on its use. However, this is for the building contents only. There is no consideration to additional fuel load contributed by the structure itself.

Therefore, Part B guidance should only be applied in buildings where the structure is not anticipated to burn and contribute additional fuel i.e. either non-combustible construction or fully encapsulated CLT as noted above.

Fire performance of CLT

A 60 minute design fire resistance period in accordance with Eurocode (BS EN 1995-Parts 1-2) would assume a char layer will build up over time along the external surfaces of exposed timber structure during a fire. This char layer is then understood to insulate the inner portions of the structure to ensure continued structural stability. The phenomenon also leads to eventual self-extinguishment of the timber.

However, as CLT burns unpredictably and has a tendency to undergo cyclical burning rather than build up char, the application of the Eurocode method may not be suitable for demonstrating the fire performance of CLT.

Achieving design intent

Although the CLT structure meets Eurocode recommendations, application of Eurocode principles is not suitable, in the opinion of the reporter, to confirm the fire performance of CLT based on its unpredictable charring behaviour.

Furthermore, the design objective of 60 minutes fire resistance may not be consistent with a full review of fuel loading as the periods in Part B do not account for fuel within an exposed combustible structure.

Lastly, even if the 60 minute fire resistance period was reasonable to withstand burnout, it is also necessary to ensure self-extinguishment of the structure as a fire decays. This cannot be assumed in general for CLT given, amongst other factors, its tendency to undergo cyclical burning.

Although the CLT structure meets Eurocode recommendations, application of Eurocode principles is not suitable, in the opinion of the reporter, to confirm the fire performance of CLT based on its unpredictable charring behaviour

Risk of collapse in fire

These concerns suggest to the reporter an unacceptable risk of collapse in the event of fire. What is most concerning is that these types of practices are becoming increasingly common in the industry. Guidance of both Part B and the Eurocode are easy to apply incorrectly. There are likely many other buildings, says the reporter, with exposed CLT structure which pose undue risk of collapse in fire.

In consideration of the above, the reporter recommends that the Eurocode and/or Part B guidance be explicitly changed to identify and mitigate specific fire safety risks of using exposed CLT in structural construction.

C Expert Panel Comments

In the drive to meet the commitment to achieve net zero carbon by 2050, the use of CLT and other modern methods of construction will lead to changes to traditional construction. This report questions whether the building regulations guidance has kept up with some of these changes.

This could potentially lead to the construction of buildings that may not satisfy the functional requirements of the regulations or the expectations of the owners and their insurers. Some of these buildings might allow fire development that could endanger the occupants, neighbours and firefighters.

Identifying the risks of alternative materials

The use of alternative, reduced carbon components and methods of construction should be encouraged but only when those involved in the design, construction, approval and management of the building are fully aware of the risks and relevant protective measures.

Designers have to take responsibility for their designs which means understanding the limitations of codes, and the reporter's case study demonstrates the importance of abiding by this principle.

The recommended fire resistance periods given in Part B are not simply about evacuation times, but also firefighter safety and the safety of people in and around the building. Designers should also consider the preservation of the building itself, and its contents, and prevention of adverse environmental consequences from an uncontrolled fire.

Whilst the Approved Documents are not explicit about the assumptions that sit behind the guidance, there is a wealth of industry and academic literature that details the principles of design for burnout.

Duty of care

For engineers who are using innovative construction materials, their professional duty of care requires particular diligence in checking that commonly applied design assumptions have not been invalidated by their chosen materials or systems. CLT can be used if it has been designed in a thoughtful and correct way with guidance from specialists if necessary.

> **CLT can be used if it has been designed in a thoughtful and correct way with guidance from specialists if necessary**

In response to comments by the Fire Sector Federation via the Building Control Alliance (BCA), The Structural Timber Association (STA) has recently published **Structural timber buildings fire safety in use guidance (Volume 6)>** which provides guidance on how designers ought to deal with these matters. This sets out credible pathways to demonstrating compliance with the requirements of the buildings regulations that go over and above the prescriptive fire resistance requirements stated in the Approved Documents.

Accidental loading conditions

Chartered Structural Engineers working on building designs of all types (including multi-storey mass timber buildings) will be aware of the requirements for accidental loading conditions, including fire, as detailed in Approved Document A. Clause A3 of Schedule 1 in the **building regulations>** states that *'the building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause'*. In this context, an accident would include fire.

CROSS is very aware of the importance of CLT and fire, and wishes to engage with all parties to improve knowledge and ensure the safety of occupants and firefighters. More reports and feedback are welcome.

CROSS encourages all interested readers to view the following additional resources:

- **The rise and rise of fire resistance, Fire Safety Journal>**
- **Fire safety design: we need to talk about timber, IStructE>**
- **Adequacy in structural fire engineering, IStructE>**
- **We need to talk about timber: fire safety design in tall buildings, IStructE>**
- **Fire safety design in modern timber buildings, IStructE>**
- **Manual to the Building Regulations – A code of practice for use in England, HM Government>**

Submit Report

Submit Feedback

Dangerous design of a retaining wall

CROSS Safety Report Report ID: 989

Serious errors were made in the input to a computer program used for designing a 1.8m high retaining wall.

Key Learning Outcomes

For civil and structural design engineers:

- A quality assurance system within your organisation, that includes the internal checking of calculations, can help prevent safety issues with computer programs from occurring
- Competent supervision of design by experienced personnel can allow less experienced engineers to develop a feel for the right solution
- It is good practice to carry out sense checks and validate all design outputs from proprietary design and analysis software
- The importance of validating software is noted in the Institution of Civil Engineers Civil Engineering Journal August 2013 **The importance of understanding computer analysis in civil engineering>**, and in the Standing Committee on Structural Safety (SCOSS) Topic Paper 2018 **Reflective Thinking>**

For the construction team:

- Be aware that brickwork is generally not suitable for retaining wall construction
- There have been numerous failures associated with freestanding masonry walls and a previous Alert was issued by SCOSS – **Preventing the collapse of freestanding masonry walls>**

For clients:

- This report demonstrates the value and importance of technical acceptance checking in mitigating safety issues within a client organisation

R Full Report

A design submitted for approval to the reporter, who was the technical acceptance authority for the client, was a 1.8m high brick retaining wall with a parapet on top, to support an access to a new building. From the reporter's experience, the retaining wall looked slender and the design was queried.

The designer said that a computer design package had been used which showed a factor of safety of over 2 for overturning and sliding so they maintained that code checks were satisfactory. This did not seem credible to the reporter.

Also, the design showed inadequate fixity of the wall parapet so the lateral force from the parapet would not be added to the overturning moment and forces at the base of the wall.

Design input errors

The design was resubmitted and this time the calculations showed that the retaining wall had been designed as panels fixed vertically at 4.5m centres (no buttresses specified). Boundary conditions giving fixity at the movement joints between the panel had been wrongly entered into the design program. A dangerous assumption as the wall was a cantilever.

A further input error, and a lack of checking, had presumed a ground bearing pressure of 800kN/m^2 rather than the bearing pressure of compacted fill on site of around 150kN/m^2. This meant that the foundations were incorrectly passing the overturning and stability checks. When challenged on the above, the designer admitted fault with the bearing capacity values but still maintained that the assumed brick support conditions were adequate and anything else would be 'overdesigning'.

> **When challenged on the above, the designer admitted fault with the bearing capacity values but still maintained that the assumed brick support conditions were adequate and anything else would be 'overdesigning'**

Are parapet fixings deemed as non-structural?

The designer also maintained that the fixings at the parapet into the wall were an architect designed item and hence non-structural. The wall was finally redesigned in reinforced concrete with a brick facing skin.

Several causes identified

The reporter feels the following causes can be taken from this incident:

- Over-reliance on computer design packages
- Inadequate experience of designer undertaking calculations
- Inadequate checking of design (and sense checking)
- Incorrect assumption that structural fixings were an architect designed item
- Incorrect assumption that forces from fixings would not translate to the base of the wall
- A designer not being open to having their design challenged

> **It is essential that there is adequate supervision of design by experienced personnel to allow less experienced engineers to develop a feel for what is the right solution**

C Expert Panel Comments

In this case there has been a catalogue of errors with design and a number of grossly incorrect assumptions. Had the authorities' assurance engineer not called these into question, and the wall was built, it would have been a dangerous structure liable to failure during or soon after construction

The importance of checking designs

The skills of design are only learned by much repetition of routine design tasks which develop a 'feel' for what is right and what is definitely wrong. Any experienced designer should have known, without calculation, that a 1.8m high retaining wall is not feasible in normal brickwork, and that a bearing pressure of 800 kN/m^2 is not credible save on rock. If 800 kN/m^2 were credible, base design would be governed by overturning. So, the safety concern here is not so much the individual errors, but that there are people producing designs who are either incompetent or badly supervised.

No firm should have allowed a design with such errors to be submitted to a third party. The safety lesson is that all designs should be checked by experienced personnel and that all inexperienced designers need to develop an eye for what is right without calculation.

The assurance engineer should never have had to pick up these fundamental errors. This should have been done within the checking and quality assurance regime within the design office of the originator. Indeed, had the client not had a final safety check, the original design could have been built.

Validating design and analysis software

It is essential that there is adequate supervision of design by experienced personnel to allow less experienced engineers to develop a feel for what is the right solution, rather than blindly using software and modelling in the hope that this will deliver satisfactory designs. It is also essential that both designs are properly checked and that all assumptions are verified before issue to a client or contractor.

This episode is a salutary lesson to the industry that we need to 'up our game' and ensure design, checking and supervision are undertaken by competent experienced personnel. It must always be remembered that cantilevers are safety critical structures and that design programs are only as good as the correctness of input.

The importance of validating software is noted in the Institution of Civil Engineers Civil Engineering Journal August 2013 - **The importance of understanding computer analysis in civil engineering>**.

Submit Report

Submit Feedback

Contractor notches steel transfer beam

CROSS Safety Report Report ID: 829

A transfer beam with 50mm thick flanges supporting a four-storey building was notched, without approval from the design engineer, to accommodate suspended ceiling fixings.

Key Learning Outcomes

For designers working with engineers:

- Check with the structural engineer for any special requirements associated with transfer structures and ensure careful consideration is given to tolerances for service zones

For the construction team:

- Never make unauthorised changes - always seek approval from the design engineer
- Quality control and competent supervision of subcontractors on site can help prevent unauthorised alterations from occurring

For clients appointing contractors:

- Competent contractors should be appointed to undertake and deliver the project

For civil and structural design engineers:

- The design of transfer structures has stricter criteria than for normal beams
- Be aware that deflection can be a major constraint for the design of transfer beams and guidance is available
- Proper coordination and detailing can ensure that tolerances that may be required for secondary structures and fixings are provided

R Full Report

Due to planning restrictions on height, says a reporter, an engineer designed a shallow depth steel transfer structure to support a four storey building above. The main beams had flanges of 50-60mm thick. When the building was structurally complete, there was obviously a certain amount of deflection in the main beams.

A follow on contractor erecting aluminium T-section ceiling grids, found that the legs of the T-sections fouled the beam's bottom flange. To overcome this, the contractor simply cut notches in the flange. Fortunately, this was spotted and repaired.

C Expert Panel Comments

This is clearly a matter of competence of the contractor but raises several questions:

- Was the contractor selected on the basis of their experience or was it simply a matter of cheapest cost?
- Was the designer of the structure aware of the ceiling grids, and did they allow for a deflection zone?
- What were the quality assurance processes on site?
- What was the level of supervision of the contractor?

A simple report of a simple error, but one which could have had serious consequences.

Is education the key to mitigating basic errors?

The operatives undertaking this work may have been trying to make things easier for themselves to get the job done with a lack of appreciation for the consequences of their actions. Had there been any engineering presence on site, or competent supervision, this could have been prevented. The industry needs to step up by educating construction teams not to make such basic errors which could have catastrophic consequences.

CROSS has seen similar examples which would also have potentially very serious consequences. Less competent contractors seem to think that designers use excessive factors of safety and therefore a notch here and there is not going to be a problem.

> **Had there been any engineering presence on site, or competent supervision, this could have been prevented**

The need for proper coordination and detailing

The basic safety violation is clearly that of making unauthorised changes. In this case that was especially dangerous since alterations were made to a member that was obviously a major structural item.

But another overall comment can be made; design is not just sizing members. Design includes the activity of co-ordinating a structural system so that all components fit together properly, negating the need for alterations. Necessarily, that process involves a proper appreciation of any movements and tolerances that might affect alignment.

Deflection of transfer beams

A wider issue is the deflection in transfer beams. The use of engineering judgement is signalled by BS 5950, EC3 and numerous other reference documents regarding deflection control.

Some would argue for transfer structures, a limit of between L/500 to L/1000 for total deflection, depending on the span or the nature of the loads and structure supported; or an absolute limit of 15mm rather than a proportion of the span. These figures aim to be comparable with the stiffness of foundations that may typically settle a maximum of 12-15mm in low rise, 3-4 storey buildings.

There is guidance available on the design of transfer structures including the paper Structural Design of Transfer Structures [1]. The extract below, is worth reading in this context:

'In general, building codes refer span/250 as an appropriate limit value for the vertical deflections of beams and slabs, for the quasi-permanent loads. Furthermore, span/500 is normally an adequate limit for deflection after construction, meaning the deflection which occurs after the addition of partition and finishes'.

Currently, there is not much guidance as to the deflection limits for transfer structures, although it is commonly accepted that their design should follow more severe criteria than normal beam or slab elements. This can be achieved either by imposing stricter limits or by designing for a more severe load combination, such as frequent loads or characteristic loads. Despite this, the serviceability criteria for global transfer structures must be specified for each project and agreed with the client.

The reporter does not mention how the remedial work was done. Repairs to a notch in a thick steel flange in tension requires care and consideration.

1. Structural Design of Transfer Structures, Ribeiro. G. Technical University of Lisbon (2018)

Submit Report

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Major safety defects in hospital

CROSS Safety Report Report ID: 826

A number of construction defects were found in a hospital following the inspection of the external wall system.

This is one of a legacy of defects that are being found during surveys prompted by the failures identified by the Grenfell Tower tragedy.

Key Learning Outcomes

For clients:

- Demonstrably competent contractors should be appointed and retained through to completion to safely deliver the project in accordance with the design
- Use quality and safety as key performance indicators

For design engineers:

- When contracted to do so, attend site at key stages to inspect the works to ensure they are being built in accordance with the design

For the construction team:

- Significant defects, related and unrelated to fire safety, are being found in buildings during inspections following Grenfell

For building owners and managers:

- Planned inspections and maintenance is necessary to keep a building safe and identify any safety issues that may need to be addressed
- Consider the findings and extent of any issues identified and assess if there is an increase in risk, including how those findings may affect other fire safety provisions
- Serious deficiencies may need to be brought to the attention of the regulator and/or the fire and rescue service

R Full Report

A reporter says that they are beginning to see defect discovery widening out from the inspection of external wall systems on projects prompted by the Grenfell Tower fire.

It is interesting to consider that there may be future financial pressure from insurers on designers and contractors to have a higher level of appreciation of the importance of construction details. This is due to the high cost of remedial work on construction defects that have been discovered, while inspecting fire protection measures on structures across the UK.

Defects in a hospital raise concerns

On one large new hospital, an initial survey was carried out to determine if there were any aspects of the cladding that were a fire risk, and this revealed that there could be other problems. Further investigations found issues concerned with the structure, the roof, fire safety and mechanical and electrical installations.

C Expert Panel Comments

The contents of this report repeats those from several others that have been received since the Grenfell tragedy. The consequences from the event are widening as there is more recognition of the legacy of poor quality construction and the inherent safety risks.

Defects in new hospitals

Major projects procured by large publicly funded organisations such as NHS Trusts have proved sometimes to be challenging. There are reports in the public domain of defects in the construction of new-build hospitals including some in Liverpool, London, Glasgow, and Edinburgh.

A range of problems have been uncovered with safety and financial implications. The impact in terms of reputational damage, increased costs, time delays and effects on patients has yet to be determined in many cases, and the potential risk to occupants and firefighters must be recognised.

It is not just hospitals that are affected and, as has been said by Dame Judith Hackitt, there must be cultural changes throughout the industry. Of course, many projects are constructed safely with designers and contractors acting diligently and competently but there are those who, from lack of knowledge or deliberate acts, fall below the standards set in law and expected by the public.

Improving competency

The work of the **Construction Industry Council>** (CIC), and others to improve competency will help as will the work of the **Get it Right Initiative>** (GIRI). The CIC published a report entitled **Setting the Bar>** in 2020. This report details industry wide proposals to raise awareness of safety critical competence requirements. The new Building Safety Bill will have a major impact down the line, and it is to be hoped that there is not another tragedy caused by poor design or construction practices.

The report highlights the need of all parties to consider not only the details of design, but how these are to be implemented in the final building. It is clear that there is a significant role to be played in inspecting works on site, and this should not be left to building control, who are not there to be a quality control check.

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Site inspections

There is certainly a beneficial role for designers to inspect that their design intentions have been met on site, and for independent third party inspections to ensure quality control.

It further demonstrates the need for involvement from the fire engineer across **RIBA Plan of Work>** stages, particularly site inspections during the construction phase to confirm that the strategic elements of the fire safety design are being appropriately implemented.

It is important that those carrying out site inspections are competent to assess the area they are inspecting and fully understand the importance of what they are checking and its impact on safety.

Immediate actions on discovery of defects

It is imperative that findings from fire risk assessments for premises are reviewed by a competent person and acted upon, including any temporary mitigation. This is paramount in all premises and especially where there are vulnerable occupants whose safety in event of fire will be relying on structural fire safety and compartmentation to support the premises evacuation strategy.

As ever CROSS welcomes more reports of such matters so that lessons to be learned can be passed on to others.

Submit Report

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