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 68 | **March 2023**

- Potential dangers in misusing fire safety terminology
- Corrosion concerns on a pedestrian bridge
- The application of rule-based guidance and potential alternative approaches
- Further example of incorrect finite element modelling

Share knowledge to help create a safer built environment

Editorial

Our thoughts are with everyone affected by the earthquakes that have struck Turkey and Syria. At the time of producing this editorial we are seeing pictures of the impact on buildings and remarkable rescues, but everyone will be moved by the scale of the human tragedy.

CROSS relaunched in March 2021 with a new website and extended remit to include fire safety reporting. The CROSS team built on the experience of the existing structural safety system, designing and building a website that brought a new look and feel, providing the gateway for reports to be submitted and read. The change of name to "Collaborative Reporting for Safer Structures" reflected the extended scope but retained the well-established acronym. The initial fire expert panel has now been extended to include eighteen members, bringing together a powerful range of knowledge and experience, helping ensure that published CROSS reports maintain the expected standard, sharing key learning points and flagging potential concerns to avoid future failures.

The expansion has been supported by the Government Building Safety Programme, reflecting the commitment to deliver against all Dame Judith Hackitt's recommendations. Whilst CROSS has been busy delivering the expanded service, other recommendations are being progressed, most notably the passing of the Building Safety Act, enabling the creation of the new Building Safety Regulator (BSR), set up within the HSE.

The changes to legislation in England were the subject of a discussion at a recent CROSS expert panel meeting. Looking through the lenses of the impact on people, processes and products, the panel reflected on the changes that have taken place and those in the pipeline.

Human actions or inactions are frequently referenced as reasons for issues raised in CROSS reports. The report produced by the Competence Steering Group, "Setting The Bar", recommended that people involved in safety critical tasks should be competent to carry out their role and that their competence (defined to include skills, knowledge, experience and, importantly, behaviours) should be tested by a body that is itself tested by UKAS, The Engineering Council or similar. One of the three main functions of the new BSR is to help and encourage professionals in the built environment industry and building control to improve their competence. There are ongoing activities to develop specific means of testing people for their competence to work on in scope buildings , generally referred to as "contextualised registers", aimed to help clients and Principal Designers and others locate the right people to help design and build safe buildings.

The impact in terms of increasing the likelihood that a competent professional with relevant experience is deployed at design, construction and handover is welcomed. Oversight is expected to fall within the remit of the Industry Competence Committee, currently set up in interim form. There are two notable exceptions; the role of the Architect's Registration Board has been revised and the BSR is to take over the responsibility for competence of Building Control Inspectors. Both professions are preparing for closer scrutiny, especially in areas such as maintaining knowledge, where CROSS can play a useful role in helping keep people up to date. It is expected that the creation of the means to identify competent persons should lead to an overall improvement in the deployment of such people.

There are many processes involved in building safety. The Grenfell Tower Inquiry examined the role of building control, in particular with regards to approvals of design, construction and checks prior to occupation. A change has been introduced via Planning Law, creating a requirement that plans for in scope buildings must be submitted to the BSR, commonly referred to as Gateway One. Gateways two and three, commencement of construction and pre-occupation, are to follow; again, only for in-scope buildings. The broader impact of these changes,

Contents

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and how the processes operated by the re-energised Building Control Bodies, will help raise the bar for out-of-scope buildings isn't yet known.

The third leg of the safety tripod, products, is also receiving close attention. The Office for Product Safety and Standards will be the home of a new Construction Products Regulator. Work is ongoing to build this function and to prepare a legislative regime that will help industry source and identify suitable safe products and to monitor their performance in use.

Structural Engineers, Fire Engineers and others involved in the design, construction and management of buildings should be prepared to be challenged to demonstrate competence, CROSS will continue to help by providing relevant information and trusted, independent, analysis in our published reports.

More have been published on our website this month and ten of these, on structural and fire safety subjects are included in this Newsletter.

Neil Gibbins QFSM FIFireE HonFIStructE,
Fire lead, CROSS-UK

[1] For the in-occupation part of the new regime, higher-risk buildings are defined in section 65 of the Building Safety Act 2022. These are buildings which are at least 18 metres in height, or have at least 7 storeys, and have at least two residential units.

More from CROSS

Request a CPD talk from CROSS-UK >

The CROSS Team is available to give presentations to firms and organisations. These give insight into the work of CROSS on structural and fire safety which include examples of failures and the lessons that can be learned. To request a talk please **complete the form>** and we will be in touch to organise.

Seen or experienced a safety issue? Share with CROSS >

CROSS-UK welcomes reports about fire safety and structural safety issues related to buildings and other structures in the built environment. If you have seen a near miss or incident or have knowledge of a safety issue submit a report so we can distribute the lessons learned. Reporting is confidential and all reports are anonymised.

Building Safety Act Conference >

The Institution of Structural Engineers are hosting a hybrid event which will feature a keynote address from Dame Judith Hackitt. This event will provide an overview of what it means for practising structural engineers.

Newsletters from other CROSS regions

The AUS and US regions of CROSS are due to publish their latest Newsletters in March, make sure to take a read for applicable lessons learned from these international safety reports.

Visit:
www.cross-safety.org/uk

Email:
team.uk@cross-safety.org

Potential dangers in misusing fire safety terminology

CROSS Safety Report Report ID: 1130

A reporter highlighted the issue that there are cases where inconsistent and inaccurate fire safety terminology is used.

Key Learning Outcomes

Regulators, Enforcers, Designers and Engineers:

- Use terms and phrases relating to building safety in a consistent manner
- Make use of fire safety vocabulary standards, such as BS4422, when appropriate
- Be aware of the ever-changing fire safety landscape and adopt terminology as it evolves
- In case of doubt explain the meaning of technical terms

R Full Report

Explicit and unambiguous communication is essential in the work of professional engineers. Many terms related to fire safety in buildings use everyday language, however they may take on specific technical meanings which may not be fully aligned to the common meanings. This adjustment sometimes happens with the aim of improving comprehension for non-specialists, but it can potentially distort the topic unless explicitly addressed.

As an indication, the reporter has encountered this general issue of misleading or misapplied terminology in discussions on what is a high-rise, a higher risk residential building (HRRB), a tall building, a complex building, and most importantly what constitutes a common building situation.

The reporter wishes to raise awareness on the issue, highlighting the fact that different participants in the design process might have a different understanding of the same term and that there is no universal common base yet. They welcome comments of similar experiences and examples, and until this issue is resolved centrally, they encourage the explicit clarification of terms used in professional activities, so that any potential confusion, ambiguity, and miscommunication is reduced.

C Expert Panel Comments

The reporter has raised a very interesting area for discussion because poor communication is a source of danger in any technical environment. While it is outside the scope of CROSS to clarify fire safety terminology, it is considered of value to raise awareness about miscommunication and how this affects safety issues. There is a need for all stakeholders to make clear what they are referring to, and ensure they 'introduce' phrases or acronyms in order to follow best practice.

BS 4422:2005 - Fire Vocabulary>, which is currently being revised, will address some of these issues, and unify the terminology used. Similarly, **BS EN ISO 13943:2017>** also clarifies the key terminology used in fire safety

News Roundup

In every interval between CROSS Newsletters, failures of some kind or incidents related to structural and fire safety are reported in the press. Here are some accompanied by a brief comment:

1. Turkey-Syria Earthquake >

In February a massive earthquake struck Turkey and Syria. Hundreds of dramatic building failures occurred. The death toll (largely from these collapses) may exceed 50,000. There can be no stronger example of the demands on building safety.

2. Fire risk from lithium batteries. Waste fires > House fire >

The fire risk from lithium batteries continues to be in the news. Domestic fires initiated from scooters and electric bikes have been reported and discarded batteries have been a hazard causing numerous waste fires.

3. Housing developers given ultimatum >

The fall-out from the Grenfell Fire continued. Government gave developers an ultimatum to fix unsafe buildings.

4. Gas explosions >

Domestic gas explosions are relatively common. A particularly bad one occurred in Jersey which destroyed a three-storey residential block and killed 10.

> **it is of value to raise awareness about miscommunication and how this affects safety issues**

engineering testing and applications, with the addition of providing terms that are deprecated and should not be used. *However, the former standard 'does not include terms for which the standard dictionary definition is applicable. Neither does it include terms and definitions which are unique to any small specialised discipline within fire safety'.* The latter standard is an ongoing project which is expected to be updated in the future.

For example, there is a significant difference between a 'fireman's lift', a 'firefighting lift' and a 'firefighter's lift' and the level of protection these infer or offer. The term 'fire door' is another example, often referring to either a fire exit or a fire resisting door. Another use of terminology that leads to confusion is 'smoke control', which can be a generic term used for 'smoke clearance, natural ventilation, mechanical ventilation or pressurisation systems'. The panel has also noted some confusion over 'fire resistance' and what that means (in terms of resistance, integrity, and insulation), with many thinking it means a product is 'fireproof' (which is a term wrongly used), and it often incorrectly gets confused or interchanged with the term 'fire retardant'.

Government consultations

The government is currently working through a consultation on classifying groups of buildings and the terminology which would be most appropriate to refer to these, so that they can be covered by the new Building Safety Regulator.

Publications from HSE and the BSR refer to HRB (Higher Risk Building) rather than HRRBs which is not now used.

The **EU Firestat project>** also recognised similar issues of terminology in the collection and analysis of statistics, and proposed a harmonised set of definitions and methodologies, with the hope it undergoes a standardisation process. The project's final report can be accessed **here>**.

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5. Hotel aquarium collapse >

A major collapse illustrating links between modes of failures, consequences and design standards occurred in Berlin. The world's largest freestanding aquarium collapsed 'instantly' within a hotel lobby releasing a million litres of water and all the fish. The mode (instant and total) was highly undesirable, and the financial consequences would be very significant.

6. Importance of temporary works >

The dangers of instability during construction were once again highlighted by the collapse of a wall which killed a site worker.

7. Riverbank flats experience landslip >

In Bristol fears were raised over the stability of a tall building when riverbank land slips occurred around its foundations.

8. Risk of collapse in older buildings >

All structures deteriorate and safety requires proper and prompt maintenance. A government report has raised the risk level of school buildings collapsing to "very likely", after an increase in serious structural issues being reported – especially in blocks built in the years 1945 to 1970. Previous reports have raised similar concerns over hospitals.

Corrosion concerns on a pedestrian bridge

CROSS Safety Report Report ID: 1161

A reporter is concerned about a pedestrian bridge that may have reduced load capacity due to corrosion at the root of cantilever supports.

Key Learning Outcomes

For asset owners and managers:

- Regular inspections and maintenance can help keep a structure safe before it deteriorates and requires costly repairs
- Inspections should be carried out by suitably qualified and experienced personnel

For civil and structural design engineers:

- The detailing of structures, particularly to ensure the effective shedding of water, is fundamental to their durability
- The corrosion protection specification for structures is important
- Cantilevers give cause for concern as they have no redundancy

R Full Report

A reporter is concerned about a pedestrian bridge that they believe has reduced load capability due to corrosion in the cantilever deck supports as shown in Figure 1 below. With hundreds of people using the bridge daily, says the reporter, the danger should not be neglected. The location of the corroded parts is very unfavourable being at the root of cantilevers where there is high bending moment and shear.

Figure 1: corroded cantilever deck support

The reporter believes the situation has come about due to the structure not being adequately checked as a matter of routine. The reporter goes on to say that all existing structures used by the public need to be checked periodically to avoid unacceptable structural deteriorations. In this case, the capacity of the cantilevers should be assessed and verified to ensure that they can withstand the loadings according to appropriate regulations.

The reporter has notified the local authority as to the condition of the structure.

C Expert Panel Comments

The corrosion appears significant, but in cases such as this, it may be difficult to understand the structural implications without removing the corrosion and assessing the steel section loss. Assessing the extent of deterioration and measuring the

More CROSS reports

In addition to the reports included in this newsletter, the following CROSS reports have also been published since our last newsletter:

Failure of cantilevered stone staircase (Report ID 1147)>

During the renovation and change-of-use conversion of a former minor stately home built around 1830, under pedestrian loading, a 'cantilevered' stone staircase partially collapsed without warning.

The potential for expertise asymmetry in aspects of the design of tall buildings in the UK (Report ID 1143)>

A reporter is concerned about the potential for 'expertise asymmetry' in the fire safety domain, with a focus on smoke control systems.

Construction period of RAAC planks (Report ID 954)>

A reporter says that there are structural issues with reinforced autoclaved aerated concrete (RAAC) panels installed in a building as late as 1998. This date is significantly later than previous reports suggest as the last significant use of RAAC elements in the UK.

Frustration about getting a response to a public safety concern (Report ID 1154)>

A member of the public reported a partially collapsed retaining structure to bodies they believed could be the responsible authority. Despite continued efforts to get attention to the issue, there was no apparent action to address the concern. This raised the reporter's concern for public safety.

thickness of the steel that remains appears to be necessary. This investigation and the follow-on assessment of capacity should be done as a priority. Cantilevers always give cause for concern as they have no redundancy and corrosion at the root can be a serious matter. Corrosion, as shown in this example, will continue and the structure potentially fail, unless steps are taken to remediate it.

Asset management regimes

Regular inspections of assets such as bridges are essential. All bridge structures should have an appropriate inspection and maintenance regime regardless of their ownership by a public or private body. Good practice, such as set down in **National Highways DMRB document CS450 Inspection of Highway Structures>**, is followed by many UK highway authorities. This standard sets down inspection types and frequencies that are designed to ensure the safety of the structure and facilitate effective long-term management including maintenance. Design sign-off would normally include confirmation of the operational plan to manage the structure during its life. Other key related aspects of asset management include:

- all structures to be included in a managed asset database
- undertaking reviews and audits of the quality of inspections
- an escalation process for safety issues discovered during an inspection
- using trained and competent inspectors e.g. LANTRA managed **Bridge Inspector Certification Scheme (BICS)>**

Durability

Finally, but very importantly, too often 'design' is thought of as a process to keep stresses under limits, however, that is just part of the process. Design includes achieving sensible durability and maintenance and certainly, on exposed structures, ensuring that water can be shed effectively. The value of a least weight design, which just a few years later when some of the steel section is lost and repairs are required, should be questioned. Detailing the fabric of the structure to achieve the required durability and avoid expensive repairs and breakdowns is essential. Alongside detailing, the corrosion protection specification for structures is also fundamental. It should also be noted that once a structure has been allowed to corrode significantly, after repairs, it may be impossible to achieve good surface preparation before repainting. Whatever paint system is subsequently applied is unlikely to last as long as the original surface protection system. So, structures with significant deterioration may have an increased inspection and maintenance requirement.

CROSS has reported previously on bridge corrosion, including report 772 **Corrosion of bridge girder beams>** published in 2022 where hidden critical elements were of concern.

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RAAC planks in a 1970s shopping centre (Report ID 1155)>

An existing large shopping centre built circa 1975 had a number of external storerooms and loading bays with roofs constructed using reinforced autoclaved aerated concrete (RAAC) planks. The planks had deflected to the extent that they needed replacing.

Cantilever bridge parapet falsework failure (Report ID 1159)>

A reporter has experienced the failure of cantilever parapet falsework twice, for different reasons, using two different products during bridge construction.

Wrong length blind bolts lead to unsafe bridge structure (Report ID 1185)>

Bridge strengthening being carried out using blind bolts left a structure in an unsafe condition with traffic loading on it.

Glued on stainless steel panels fall (Report ID 1187)>

A ceiling in a retail setting was designed to be faced with reflective finish panels. The contractor proposed stainless steel bonded to MDF with folded edges and concealed mechanical restraint. The designer overruled the contractor and selected an adhesive-only solution which was implemented. Some months later, several panels failed, with some stainless steel facings falling to the floor.

The application of rule-based guidance and potential alternative approaches

CROSS Safety Report Report ID: 1142

A reporter raised with CROSS a series of questions and opinions about the treatment of fire risk in buildings and rule based guidance requirements.

Key Learning Outcomes

Designers, Architects, Fire Engineers, Building Services Engineers:

- Buildings that rely on active fire precautions to meet safety requirements should be tested for the impact of failures of such systems and/or occupancy by persons not taken into account by standards, such as persons with reduced mobility
- Designers need to be aware that following guidance blindly may not meet all needs of the occupants
- Cognisance of where rule-based guidance has come from and what has informed it is also key for the proper application of the rules

Full Report

A reporter raised with CROSS a series of questions and opinions about the treatment of risk in buildings and rule based guidance requirements.

For the purposes of this report, the reporter considers that any building where fire safety is dependent on systems other than passive fire protection can be considered a complex building. This can also usually be the case for Higher Risk Residential Buildings (HRRBs), or buildings where the occupancy characteristics may necessitate the employment of more sophisticated analyses and solutions. This can sometimes be sparked by changes in the design of safety solutions due to natural effects and specific triggers (for example the stack effect in ventilation systems, or different approaches in the design of sprinkler systems beyond a specific number of floors and heights).

It has become generally common knowledge in the fire safety industry that, as it is phrased in Approved Document B, *'those with responsibility for meeting the requirements of the regulations will need to consider for themselves whether following the guidance in the approved documents is likely to meet those requirements in the particular circumstances of their case'.*

Built-in assumptions and latest research

The reporter is of the mind that in order to most successfully meet the requirements of the regulations in cases of complex buildings, designers ought to be aware of the historical developmental processes of technical guidance to cultivate an understanding of the built-in assumptions. Additionally, designers should keep themselves aware of the latest research findings in the field, because the results may sometimes expand and add to existing guidance provisions. These might be utlised before the lengthy process of formally incorporating them in their practice. Reciprocally, there may be research findings that contradict existing guidance provisions, and practitioners should be wary of them until they are addressed by the appropriate guidance bodies.

Consideration of persons of reduced mobility

An example of such a case may be the ongoing consideration of persons of reduced mobility (PRMs) as occupants in a building. A fire safety solution that follows available guidance, and may be perfectly acceptable without such considerations, can potentially, under an updated perspective, be found wanting if provisions for PRMs are needed. According to the reporter, these distinctions become harder to navigate and address as the levels of complexity increase in the safety arrangements of a residential building.

This becomes even more complicated when one considers the deterministic philosophy that is employed in rule-based guidance. While levels of redundancy exist, these are not explicitly considered. The reporter cites that the underlying assumptions in some historical guidance were that some safety systems will always activate and operate successfully. The reporter thinks that this might not be realistic and will not always hold. While for the majority of the cases the guidance is very successful in implicitly providing acceptable safety levels, there may be a high-consequence safety environment

where, according to them, an explicit risk-based approach may be more appropriate.

Assumptions around smoke control systems

The reporter is of the mind that only through a complete probabilistic risk analysis can single points of failure, along with the interdependencies amongst safety systems, be explicitly and thoroughly considered. An example of that can be the assumption that a fire is always suppressed (either by fixed active suppression systems or fire brigade intervention) in order to design a smoke control system. This may not always be true as such systems have a failure rate which may be big or small. A designer may assume that some layers of safety can be stripped (e.g. the removal of passive smoke seals in doors because they are not necessary in the scenario that suppression is successful and the smoke control system can cope with the smoke production). However in the low probability/high consequence event that the initial safety system fails and the fire is not suppressed, then the smoke control system is overwhelmed. This would lead to untenable conditions in protected spaces where smoke may also migrate to other compartments due to the non-existence of smoke seals. Similarly, the use of firefighting lifts and the resulting piston effect can impact the pressurisation system's performance, which may not be explicitly considered in some aspects of rule-based guidance due to its scope and the complexity of the chosen solution.

Another example, when it comes to interdependencies, can be the existence of an Evacuation Alert System, either being a partial or full alarm; this choice can affect the capabilities of a smoke control system. It will define how many doors will be open when the system is in operation and whether it can cope with the demand. This can be of importance because the tenability levels of a protected space are dependent on these capabilities. Designers ought to be aware of such considerations.

The relative 'simplification' that occurs in the codification of knowledge through technical guidance and standards does not necessarily mean that designers should follow it without due consideration of all potential scenarios. It must be kept in mind that there is potentially more analysis to be done in order to account for the impact of technical solutions upon other safety measures.

It can be hard to decide when the analysis should shift to the more sophisticated risk-based approach, like the one outlined in BS 7974, given how there remains some uncertainty around what is (or is not) deemed a 'common building situation' and when rule-based guidance is applicable. It is recommended, in the opinion of the reporter, that detailed robustness and performance checks are conducted to validate the appropriateness of solutions, and not simply to assume that adequacy is achieved if prescriptive rules are followed.

C Expert Panel Comments

The panel recognises that there is a range of opinions on what a complex building is, but support the key message in this report. Regarding the definition of a complex building, a long-standing, and used, expectation of sprinklers in ADB does not necessarily result in a complex building, or an uncommon building situation. The reverse could also be true, in the case of a complex premises relying on passive measures. Each and every case needs to be considered on its own (holistic) merits.

detailed robustness and performance checks are conducted to validate the appropriateness of solutions, and not assume adequacy is achieved if prescriptive rules are followed

Passive fire safety measures can also have a failure rate due to bad commissioning, maintenance, or misuse, and this uncertainty should ideally be accounted for in designs. Designers ought to test various failure mechanisms of their fire safety measures and check the potential consequences so as to spot weak points. This might not be appropriate or necessary for simpler projects, but the best approach is always going to be a multi-layered compilation of measures so that single points of failure are excluded from the design.

also acknowledged that designers should not be following guidance blindly

It is also acknowledged that designers should not be following guidance blindly, assuming that all needs of the occupants will be met by placing all occupants into a simple category that then informs the safety measures required. Placing all potential occupants of a premises, over its lifecycle, into one category (Purpose Group under ADB) is implicitly making assumptions about a level of mobility, and the assistance required in event of fire that the designers may need to explicitly account for in complex situations.

Cognisance of where rule-based guidance has come from and what has informed it is also key for the proper application of these rules.

Building Safety Regulator

This report is also of relevance regarding the new regime under the Building Safety Act 2022 as overseen by the Building Safety Regulator, specifically the Safety Case regime. With the limited information available so far, it could be expected that support for a Safety Case that purely references to following the recommendations of guidance may not satisfy the Safety Case requirements, and designers will need to explicitly demonstrate safety with appropriate evidence.

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Further example of incorrect finite element modelling

CROSS Safety Report Report ID: 1145

Following on from a recent CROSS report, further concerns in respect of the sufficiency of finite element modelling are reported, in particular, the modelling of masonry walls as part of a reinforced concrete framed building.

Key Learning Outcomes

For civil and structural design engineers:

- Model masonry walls as loads only, other than in exceptional cases
- Use the simplest model that is reasonably practicable
- Remember that analytical methods are approximations of true performance
- Be aware of time and temperature related changes such as creep, shrinkage and expansion
- Attributes such as ductility are fundamentally important for the safety of structures
- Ensure that those using specialist software programs understand the materials being modelled
- It is good practice to carry out sense checks and validate all analysis and design outputs

R Full Report

CROSS report 1073 **Concern over modelling of concrete frame building for construction stage>** reminded a reporter of instances where different but in some ways similar, gross errors came to their attention. One of these occurred when they were checking a full-building finite element model, but they have also seen errors elsewhere. This particular problem was picked up in checking, dealt with, and all was well. However, in talking to colleagues and software developers about their concerns, the reporter has become less confident that such issues will be picked up because there seems very little feedback and training.

The reporter goes on to say the concerning model included loadbearing and non-loadbearing walls which were intended to be constructed in masonry. The primary part of the structure was of in-situ reinforced concrete columns and slabs including a transfer slab. There were some beams but in the main, it was flat slab construction. The walls had been modelled with full attachment to the slabs with no releases other than a moment release for transverse bending. The reporter contends that this form of model will give grossly incorrect results in most circumstances and is a worrying situation. There are at least two effects at play which, according to the reporter's 'asking around' do not seem well understood by less experienced staff and some more experienced designers.

Firstly, walls will arch, and they are usually stiff enough to arch even when the masonry is much weaker and less stiff than the frame. Indeed, this can sometimes be seen in practice. The result is that the beam or slab that the engineer thinks is supporting the wall, is not receiving that load, especially near the middle of the span, so slab or beam bending moments may be significantly incorrect.

> **The effect is to introduce non-conservative errors, possibly gross errors.**

Secondly, a full connection (where in-plane shear can be transferred) will inevitably cause the wall and slab or beam to behave compositely. If the wall is of substantial height, say a storey height, it will have appreciable stiffness. The effect is to introduce non-conservative errors, possibly gross errors. Shear outputs will be affected too, however, it depends on how the wall is attached to columns, other walls, or other elements. It might be expected that most of the shear would get back to the ends, but that would not be the case if the wall has been inadvertently attached to the column, remarks the reporter.

The reporter contends that design errors will propagate regardless of whether the designer designs manually, or allows the software to generate the reinforcement from the model.

The reporter has experimented with various software packages to try to evaluate if there are any easily implemented 'workarounds'. The necessary releases can be made, but this is not always a straightforward task. It may also be complicated by how the software makes

these releases. For example, some software can release the longitudinal shear along an edge, but still have the end/corners attached. Getting all this right is possible, but it is fiddly and, the reporter fears, beyond many who are routinely creating these models.

Another thing that might tempt the user, is to 'soften' the wall material. However, this is of limited use, because the wall is likely so stiff it would have limited effect. A further idea might be to directly adjust the element stiffness matrix to make it incapable of interacting in this way. Doing so however could result in elements that are badly conditioned, and which may require much study to validate whether they are behaving and interacting as expected.

> **Doing so could result in elements that are badly conditioned**

The reporter would ideally like to see a special wall element that is a compression-only element and unable to interact in the sense of longitudinal shear at the edges and corners. The reporter has only seen one software system that might implement something like this. Wall elements can be arranged to form vertical strips – these act like a series of columns that are effectively in contact to form a wall. They might gather transverse load, such as wind, by using dummy load collection elements which are quite common.

The reporter would suggest that if a designer is not confident that they can predict behaviour or interpret the results, they stick to modelling masonry walls as loads only so that unwanted interactions cannot occur. This is inconvenient but tends to be on the safe side.

An objection might arise if walls do indeed arch. Although arching relies on things that may or may not be under the control of the designer. What happens if, for example, someone later puts a door in? What happens if a wind post is put in?

The reporter goes on to say that nearly all such modelling is done with largely blind faith in linear elastic models. If different forms of elements exist in the model, construction does not occur instantaneously and simultaneously, and there are materials with quite different stress-strain behaviours and amounts of ductility, getting anything like a realistic result probably gets less likely with increasing complexity (and arguably software capability), especially if one injects the question of user expertise. So, for most projects, the reporter would support the principle of using the simplest model that is reasonably practicable, and that computer modelling is a force for good, in the sense that, properly implemented, it promotes economy and reduces error. However, if used incorrectly the scope for error can seem disproportionate.

> **using the simplest model that is reasonably practicable**

The reporter concludes that these issues concern mainly less experienced staff, but fears that those people are progressing rapidly to positions where they are in a supervisory role, without having sufficient training. Additionally, feedback within the industry does not seem reliable. The reporter knows that there are companies in the UK (and possibly elsewhere) that try to use less expensive staff for this kind of work, maybe in the belief that it is sufficient to be able to 'drive' a computer and the software takes care of the rest. The reporter believes, however, that these roles deserve a higher profile than that and more educational input is required.

C Expert Panel Comments

The reporter raises a number of very valid points and emphasises that designers should understand the medium they are working in and that analytical methods are approximations of true performance. These approximations and their influence need to be well understood. CROSS report **Unconservative design of flat slab due to software modelling issues>** reviewed similar issues where masonry was modelled as part of the supporting structure – this report also noted the improper use of (or over reliance on) computer modelling with potential for results to be divorced from reality. As noted by the reporter, CROSS report **Concern over modelling of concrete frame building for construction stage>** explored a number of further issues related to modelling including the importance of verification processes.

The idea that engineers can do all analyses and design in a single model should be challenged. Software marketers who may not have sufficient oversight from those who actually understand how the programs work may be tempted to over-sell what can be modelled. Designers however who have been taught by engineers are more likely to understand why modelling masonry as part of a steel or concrete structure is very difficult.

> **modelling masonry as part of a steel or concrete structure is very difficult**

Finite element analysis (FEA) in its standard form only addresses linear elastic materials. There are tricks that some software developers employ to allow the use of tension or compression-only 1D elements in such an analysis, by negating their action when they are subject to axial forces in the "other" direction. These options are not suitable for compression or tension-only 2D elements, so in these instances advanced nonlinear explicit solvers are needed. These programs are usually beyond the budgets of all but a few specialist engineering firms.

Finite element analysis requires engineers to understand all the materials being modelled, however, masonry is perhaps not addressed in many engineers' academic journeys and

therefore many designers do not appreciate how modelling should take account of the engineering properties and use of masonry on site. The reporter is right to be concerned about the education basis of modelling. Arching of masonry, for example, must be carefully considered, especially when the masonry is built upon a flexible support. When each course is laid, the mortar can carry a little compression (though not much, hence the limits on how high masonry can be built in a day) and less shear. Hence arching is unlikely to occur for the wall's self-weight unless the supporting structure is propped during the wall's construction. What is then likely to happen is that subsequent loading on an under-stiffness supporting slab or beam will try to pull it away from the masonry above, causing it (the masonry) to attempt to arch and certainly to crack.

> **Squashing masonry in as shear panels will also certainly invalidate FEA stress predictions**

We also have changes of time and temperature to contend with. In this example, we have an interaction between masonry and concrete both of which exhibit time changes by creep and shrinkage and expansion and in the case of these two materials to differing degrees and possibly in opposite directions. Squashing masonry in as shear panels and not allowing soft top packs (for vertical frame shrinkage) has caused problems but will also certainly invalidate any FEA stress predictions. It must be remembered that the detailing of the joints between the concrete and masonry will allow the designer's intent to be achieved. If, however, the designer is not clear about how the structure behaves, how are they able to decide the details needed for a safe structure?

Finite element analysis of masonry can be used, with great care, to gain an insight into how forces can flow through masonry, but should not be relied on, for the design or detailed understanding of it. Except in exceptional cases, masonry should only be represented in steel and concrete FEA models as loads, with independent analysis and design checks being made on the masonry panels themselves.

Ductility is fundamentally important

Finally, we should not forget that originally all analysis was linear elastic but alarm spread when real stresses were measured in frames and it was realised there was little correlation. Out of that came the concept that design ought to be based on ultimate loads. Design then largely evolved into a procedure meaning 'do it this way and by long experience, we know the frame will be good enough'. Although this process might break down with more complicated buildings, the concept of ultimate design is quite adequate provided the structure is, as intimated by the reporter, ductile enough. However, that quality of ductility is elusive and not directly calculable and is achieved largely by detailing which is not always under the main designer's control. Some may consider it fundamentally wrong to excessively manipulate analyses to try and control stresses on the premise that stress governs everything when in real life we know that is not the case. Other attributes such as ductility are fundamentally important for the safety of structures.

Readers might find the following related reports of interest:

Report 1139 **Connection fixity considerations for steel frame modelling>** published in 2022. This report concerned mismatches that are created when connection modelling assumptions are not followed through into the design of steel structures – the mismatches potentially leading to unsafe structures.

Report 1144 **Incorrect modelling of a cantilever>**, also published in 2022, concerned a structure modelling error, that could have led to safety concerns.

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No worse than existing?

CROSS Safety Report Report ID: 1148

This report discusses the perceived exploitation of a common fire safety argument: the existing condition.

Key Learning Outcomes

For Designers, Fire Engineers, and Building Control Officers:

- Proposals to alter buildings without applying safety measures that would be required in a new building, by relying on the argument that the building will be no worse than existing, should be carefully considered
- Changes that trigger height or volume thresholds must be carefully considered, as in principle the standard should be applied to the full risk area

R Full Report

This report discusses the perceived exploitation of a common fire safety argument: the existing condition. The reporters highlight the question to be asked; "Is it truly no worse than the existing condition?"

The reporters have witnessed, through their professional capacity, a trend in which buildings are being substantially altered in their occupancy and can also be physically changed by an increase in building height or footprint, but any consideration of certain fire safety provisions is omitted on the "tenuous" basis that the altered design is not "worsening" the existing condition.

The foundation of this argument results from clauses provided in Paragraph (3) of Regulation 4 of the Building Regulations 2010, and from another clause in Approved Document B (ADB), where it is stated: *"For work on an existing building that did not comply with the applicable requirements of the Building Regulations:*

- *the work itself must comply with the applicable requirements of the Building Regulations, and*
- *the building must not be more unsatisfactory in relation to the requirements than before the work was carried out".*

Examples of this practice in recent years include the extension of residential buildings with additional storeys and the increase in the building footprint with the addition of more apartments per floor. With these examples, if the buildings were to be designed under contemporary guidance, then, depending on the building height, it would be expected to include fire safety provisions such as suppression systems, firefighting shafts and lifts, automatic smoke control within the corridor or lobby, or more.

However, the reporters have witnessed situations where the fire strategy for altered buildings omits the inclusion of certain fire safety provisions on the basis that they were not present in the existing building. Variations of this have been observed whereby the building extension incorporates the provisions expected by contemporary guidance, but the existing building portion remains largely or entirely unaltered.

While it may be anticipated that such practices are rectified during quality assurance procedures and third-party reviews, it does appear in the reporters' anecdotal experience that some of these designs are gaining Building Regulations approval and are being built and occupied, with limited concerns highlighted by the authorities having jurisdiction during the approval's process.

> **some of these designs are gaining Building Regulations approval and are being built and occupied**

The reporters acknowledge the practical difficulties and complexities that arise from making alterations to existing buildings, particularly with the retrofitting of fire safety systems. However, it is their view that in many instances the argument of "no worse than existing" is being negligently exploited to facilitate inadequate design. In the examples provided above, the addition of more storeys or more apartments per floor has the potential to substantially alter the risk profile of a building. The addition of more apartments increases the likelihood of a fire occurring, as well as the number of occupants located within the building.

It thus follows that without any appropriate consideration of the collective fire safety measures, the risk associated with fire hazards is increased. These alterations also have the potential to impact firefighting operations within the building, placing additional pressure on the fire service when fighting the fire and carrying out rescue operations.

Given the above, it is the reporters' view that, unless the existing building and new alterations are demonstrably independent, i.e., the 'existing' portions of the building do not interact with the 'new' portions, then it cannot be reasonably argued that alterations are not worsening the existing condition. However, this independence is rarely the case in practice and, in most situations, the existing building and the building extension form a holistic system of many interacting components. In this system, occupants may share common escape routes, the fire service may utilise these common escape routes to access the building, new storeys likely share the same structure as existing storeys, and so on. Ultimately, the provisions (or lack thereof) within one part of the building have the potential to substantially impact the performance of another part of the building. Under these circumstances, it is difficult to argue that the existing condition is not worsened, and the omission of any provisions expected under contemporary guidance is reasonable. Such an argument could be, at the least, based on clear evidence that the design collectively achieves an adequate level of safety, e.g., by a quantitative assessment which considers both the existing and new portions of the building (along with any potential interactions).

> **not a means of avoiding responsibility for demonstrating adequate design**

The reporters state that there are individuals within the fire safety industry that would propose that the argument of "no worse than existing" needs to be revisited or abandoned entirely, and the industry needs to do more to improve the safety of existing buildings when offered with an opportunity to do so; a building refurbishment or extension presents one such opportunity. This is a reasonable and well-intentioned suggestion, although it will inevitably come with complications and unforeseen consequences if its implementation is not carefully considered. Despite that, it appears that before the industry can ever reach that point of consideration, a minority of engineers first need to be convinced that "no worse than existing" is not a loophole to be exploited, it is not a way of circumventing difficult discussions, and it is not a means of avoiding responsibility for demonstrating adequate design.

C Expert Panel Comments

The reporters are right to raise and discuss this issue. Cases where a fire safety measure is not included with 'non-worsening' cited as the reason by the designer, engineer, or building control body are a recurring experience within the panel.

Part of the reason why this clause exists, is that building regulations are not retrospective. Engineers do not revisit every building to conduct upgrades every time the regulations change. This way, occupants are not made to upgrade everything about their existing buildings when any kind of work occurs; for example, replacing windows shouldn't necessarily trigger a need for adding structural components.

If the building work includes extending the building, particularly if that includes making it higher, then the designers would have to make sure that the new areas fully comply with current standards and that the works won't make things worse for the existing areas. It's really the responsibility of the designers to make sure that happens and for Building Control to check that this is done.

> **the new works must fully comply**

Where this is increasingly becoming misused is in deciding that things are not 'worse'. The new works must fully comply, but some people may think this means the new works can be no 'worse' than the existing. This is clearly not the case.

What is less clear is when the work has less direct impact on the existing premises. For example, in a case of adding floors to a building, to an extent that it changes classes (disproportionate collapse), then it should be seriously considered if the whole building should be brought up to current standard because the existing building supports the extension. In principle, alterations which change the fire risk profile affect the whole building.

> **alterations which change the fire risk profile affect the whole building**

Another common example of an issue is when a vertical extension triggers the need for sprinklers due to the new height, because it now reaches the threshold for a suppression system; then in principle the whole building needs the upgrade. In terms of guidance, BS 9251 (domestic sprinklers) states, when installing sprinklers in a building, that 'all parts of the premises should be sprinklered'. This is one solution that would ensure *"that the standard of fire protection for the occupants of the new accommodation is as would be provided for a new building under the approved document"*, a clarification found below, in the cited frequently asked questions on ADB.

The non-worsening clause is also commonly referred to when some designers assess the access and water supplies for the Fire and Rescue Service (FRS), and the experience of the panel is that whatever is in existence is accepted as being adequate.

The difficulties of practically achieving the holistic solution are often cited as a reason not to do things, and should be

evaluated on a case-by-case basis, but ultimately some projects should not be going ahead if it is not practicable, hence unsafe, to complete them properly.

The FRS has very limited options via the Regulatory Reform (Fire Safety) Order (FSO), as it does not provide a route to enforce retrospectively requirements of the Building Regulations, although the FSO does impose an expectation of continuous improvement and adaptation to new technologies. The latter is limited, again, in respect to a risk-based life safety assessment.

Examples in Approved Document B

Examples provided in the **Approved Document B: Fire safety - frequently asked questions>** website can be relevant in this discussion. These are reproduced below, namely questions 9 and 20:

9. If an existing single storey shop is extended so that it exceeds the maximum 2000m² compartment size, is it necessary to install a sprinkler system?

Regulation 4 (1) of the Building Regulations 2010 states that "building work" should comply with the applicable requirements contained in Schedule 1. Regulation 4(3) then goes on to state that after the work is completed the building as a whole should comply with the applicable requirements of Schedule 1 or, where the building did not previously comply with any such requirement, is no more unsatisfactory in relation to that requirement than before the work was carried out.

Where an existing shop is extended such that the final floor area is greater than 2000m² (whether it exceeded this value previously or not) then the building as a whole may be less satisfactory in relation to Schedule 1 requirement B3(3) than before the work was carried out. Therefore, the building would have to be either subdivided to limit the compartment size, fitted with sprinklers or some other solution would be necessary in order to satisfy regulation 4(3) in relation to requirement B3. Regulation 4(3) must be judged against the requirements set out in Schedule 1 rather than the Approved Document. B3(3) requires sub-division of the building "to an extent appropriate" to its size and intended use and it may be that some buildings will still comply with requirement B3(3) by virtue of its intended use even though they have been extended without further compartmentation.

And question:

20. I am undertaking work on an existing building which is below 11m, and adding a new floor which will exceed 11m in height, do I need to sprinkler the whole building or just the new floor?

Each case must be considered on its own merits, but it is likely that where additional storeys are added to an existing building, some work on the original part of the building will be necessary.

Applicants and building control bodies are reminded of the need to consider these new provisions sprinklers in relation to extensions as required by Regulation 4(1). New accommodation, formed by building work, should meet the relevant requirements having considered the guidance in the approved document. This means ensuring that the standard of fire protection for the occupants of the new accommodation is as would be provided for a new building under the approved document. In the majority of cases, therefore, sprinkler protection will be necessary in any newly formed accommodation that falls above the new 11m trigger height.

It may also be necessary to consider additional protection for the existing parts of the building where needed to ensure that the extension is compliant with the applicable requirements of Schedule 1. Equally, it will be necessary to satisfy regulation 4(3) by ensuring that the level of fire protection in the building as a whole is made no worse.

There may also be situations where the risk assessment for the building (provided under the Fire Safety Order) requires further work to be done. Regardless of the minimum requirements of the regulations there is, of course, merit in providing additional protection throughout the building.

Further advice can be found in the following circular letter>.

One for debate

Finally, as for the opinion that the approach should be abandoned entirely, this is a matter of debate. Any change in law can always have unintended consequences, in this case for any people doing very minor works. Until this debate is resolved, better enforcement of building regulations in all building types is needed. To that end, any further clarification or guidance (by Government) on how this regulation should be approached, because it being open to interpretation is recognised as the crux of the issue, is most welcome.

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The selection of principal designer and principal contractor

CROSS Safety Report Report ID: 1150

A reporter is concerned that some organisations that they would normally expect to be appointed as principal designer or principal contractor under the Construction (Design and Management) Regulations 2015 are avoiding such appointments.

Key Learning Outcomes

For all construction professionals:

- HSE publication **L153 'Managing health and safety in construction'>** provides guidance on CDM 2015
- Consider the full scope of an organisation's insurance before appointing to a project
- All practitioners have liabilities in criminal law regardless of appointments to principal designer and principal contractor roles or otherwise
- Consider the advantages of appointing the parties most competent to lead the design and construction as principal designer and principal contractor
- Be aware of the potential for development of principal designer and principal contractor roles under supplementary legislation to the Building Safety Act 2022

R Full Report

A reporter has come across, on several occasions, a concerning issue in respect of the appointment of principal designers (PD) and principal contractors (PC) as required under the Construction (Design and Management) Regulations 2015 (CDM 2015).

In one case a client was procuring fixed plant. The scope of the works was to supply and install replacement plant within an operational facility. The client was intending to procure this plant from their long-term preferred supplier who had supplied similar plant and who inspected and maintained the client's existing plant. There was also to be a small number of other parties and contractors involved in the works. The reporter considered that the preferred supplier was the best organisation to act as both PD and PC as they were specifying their own products and understood what needed to be done to isolate existing equipment during removal and replacement. However, the client's preferred supplier of the proposed equipment advised that they could not act as either PD or PC as they did not have insurance to do so.

The reporter goes on to say that the problem with competent organisations stating that they can't (or won't) act as PD and/or PC means that the client may then need to appoint third parties who would otherwise not be engaged in either the design or the construction to take on the roles. The reporter says such third parties, who have little control over the design or construction, end up being appointed to PD and PC roles and just undertaking 'box ticking approaches'. The reporter says they have seen this situation arise in several sectors and also with design and build contractors who will not accept the PD role.

The reporter contends that there are at least two drivers leading to this situation:

1. A perception that complying with CDM 2015 is 'difficult' and needs additional specialist CDM competency, rather than just professional and sector competency.
2. A perception of attracting risks and liabilities by taking on the role of PD or PC.

The reporter goes on to say that in some cases the appointment criteria in Regulation 5 of CDM 2015 are in their experience not well applied by clients. The regulation states:

'Where there is more than one contractor, or if it is reasonably foreseeable that more than one contractor will be working on a project at any time, the client must appoint in writing— (a) a designer with control over the pre-construction phase as principal designer; and (b) a contractor as principal contractor.'

The reporter's experience is that some clients do not acknowledge or interpret the 'with control over the pre-construction phase' requirement, potentially because they are not aware of its existence. The reporter considers that the HSE's guidance in the publication **L153 'Managing health and safety in construction'>** could make a stronger reference to the 'with control' requirement.

C Expert Panel Comments

The reporter raises a significant issue. Feedback from industry appears to show that a wide spectrum of practitioners is appointed to principal designer (PD) roles. At one extreme,

some practitioners believe that the regulations intend that a lead designer who can 'control the design work' should be appointed as the PD, whilst alternatively at the other extreme, some believe a party can be appointed to the PD role who would otherwise not be actively involved in 'design' of the project – perhaps only contributing with a remit to ensure the CDM regulations are followed. Between these two extremes, designers or other parties who contribute significantly, or only marginally, to the design are also appointed. This spectrum of practitioners appointed to the PD role appears to show that this aspect of the regulations is interpreted widely, by particular clients and their appointees.

Some practitioners advocate very firmly that only the project's leading designers should be appointed as PD, and that third parties and other advisers, should not be appointed as PD. Such practitioners may believe that third parties cannot control the design process and hence influence how safety is addressed during all stages of design. Clearly however, some practitioners will not share this view.

Similar arguments concerning the ability of third parties to control construction processes would be made by some practitioners when considering the appointment of principal contractors.

The general duty of the PD is to plan, manage, monitor and coordinate the design process to ensure that risks during construction can be eliminated, or at least controlled, as far as reasonably practicable, and the general duty of the PC is to plan, manage, monitor and coordinate the construction phase. Therefore, as advocated by the reporter, a specialist supplier responsible for the installation could be ideally placed to fulfil both roles.

Turning to insurance, in examples such as put forward by the reporter, if a supplier does not have insurance cover for the PD or PC role, some practitioners would ask 'why'. Is it an exclusion because there is reasonable doubt over the supplier's ability to carry out these roles? Has the supplier procured insurance cover that may also exclude other matters a client might reasonably expect to be included? It could be that an assessment of the circumstances concludes it is more appropriate to appoint other parties to the PD and PC roles.

Any tendency to avoid PD and PC appointments is perhaps not unsurprising where risk averse attitudes prevail. However, all practitioners have liabilities in criminal law under the Health and Safety at Work etc. Act 1974, the Construction (Design and Management) Regulations 2015 and other legislation which exists, regardless of appointments to PD and PC roles or otherwise. Some practitioners will believe it may be better to take an appointment so that they have a fair degree of control in managing risks and driving and recording the behaviours of others. Many practitioners will consider that it would be in best interest of the project for the parties most competent to lead the design and construction to be appointed as PD and PC and any legal or commercial arrangement that deters from that is not at all helpful.

> **all practitioners have liabilities in criminal law regardless of appointments to principal designer and principal contractor roles or otherwise**

Reforms to duty holder responsibilities under supplementary legislation to the Building Safety Act 2022 may add more clarity as to who could be appointed to PD and PC roles. It would seem that further guidance is required and would be helpful to encourage those most able to manage the risks to be responsible for them.

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The potential impact of scaffolding on fire safety

CROSS Safety Report Report ID: 1153

An issue has been raised with CROSS regarding the risk assessment process when scaffolding is present around an in-use building. It is considered that combustible scaffolding elements can potentially facilitate external fire spread, and additionally impact the performance of some of the building's fire safety measures.

Key Learning Outcomes

Scaffold specifiers, Building owners, Contractors:

- A holistic risk assessment must be carried out when adding combustible materials to the external face of a building, evaluating the risk of fire spread
- The potential for sheeting or other elements to have a negative impact on fire safety systems, such as smoke vents, must be considered
- Contractors should be cognisant with HSE's guidance document **HSG 168>**

R Full Report

An issue has been raised with CROSS regarding the risk assessment process when scaffolding is present around an in-use building. It is considered that combustible scaffolding elements can potentially facilitate external fire spread, and additionally impact the performance of some of the building's fire safety measures.

Cause for concern

The reporter is alarmed by the existence of "numerous residential buildings operating 'stay put' procedures undergoing works that have scaffolding formed of timber boards with plastic wrapping which could present a medium for fire spread". This introduction of combustible structures and elements around the external wall of in-use buildings presents a potential medium for fire spread which needs to be considered appropriately. It is also noted that other buildings with sleeping occupants or places of assembly may be affected from the same issue.

An additional complication that arises from the existence of scaffolding wraps, apart from their contribution to the heat release rate, is that it if the wrapping completely envelopes the building, then it can affect the capacity of ventilation outlets. The reporter thinks that the wrapping can trap the smoke within the scaffold structure and spread it to other parts of the building if the scaffold structure is not adequately ventilated. This situation may inhibit smoke ventilation, not just from designated ventilators, but also through the windows and other openings.

The reporter is of the mind that this fire scenario will change the Required Safe Egress Time (RSET), lowering it due to the increased rate of external fire spread. At the same time, the implication of the smoke control system's performance being affected by enveloped outlets will probably reduce the Available Safe Egress Time (ASET). If the RSET extends beyond the ASET, then that creates a potential risk for the safety of the occupants.

Fire risk assessment

The reporter is concerned that the construction industry is not appropriately fire risk assessing this issue or taking reasonable steps to reduce the risk associated with scaffolding on in-use buildings. They go on to say that the risk from fire tends to be considered only in relation to fires starting on the scaffold, ignoring fires starting in the building and spreading through the windows to the scaffold. This arguably ignores the most likely risk, which builds a false sense of security in the construction industry and is reinforcing potentially dangerous practice which can be encountered across the country.

Their explanation on the underlying cause for this issue is that fire risk assessments carried out by Principal Contractors, or their scaffolding sub-contractors, are often generic and the reporter is of the opinion that "Guidance issued by the Health and Safety Executive (HSE) is not fit-for-purpose". They support that statement by claiming that the HSE guidance focuses on risks associated with the scaffold as if it was a construction site. This is not the case, however, in occupied buildings, where there are fire hazards associated with the in-use areas of the building and these are currently not appropriately covered by the HSE's guidance. Consequently, contractors have a false sense of security that they are following the HSE guidance and suitably mitigating any risks. The construction industry

needs to be aware that the fire risk assessment associated with an in-use building with a scaffold installation present will in many cases be a specialist task that requires involvement of competent fire engineers. This can be in much the same way as a PAS 9980 fire risk appraisal of the external wall (FRAEW) would be undertaken.

Their suggestion is that in the absence of any other guidance, PAS 9980 may present a suitable methodology for approaching the issue. However, at present, construction industry norms are often to rely on "an unsuitable and insufficient fire risk assessment prepared by a scaffold contractor" without a suitable and complete understanding of the risk assessment issues involved to adequately assess and evaluate the fire risk.

Suggestions for improvement

The reporter provided CROSS with some suggestions for addressing this issue:

- The first is that scaffold designers should be specifying non-combustible materials when possible and deemed appropriate, particularly where there is limited alarm provision to initiate an evacuation.
- Continuing; acknowledging that installation of fire detection and alarm systems that initiate evacuation procedures may reduce the risk in some cases, the presence of vulnerable or disabled people also needs to be carefully considered, with appropriate evacuation arrangements to ensure that RSET is well below ASET.
- Scaffold designers should be carefully considering the issues raised in this report, namely the impact on smoke ventilation, not just from smoke ventilation systems, but also considering smoke and heat exiting the in-use buildings by windows, doors, and other openings in the external wall.
- They additionally think that advice to the construction industry is needed about the required level of competence of fire risk assessors who could carry out a suitable and sufficient fire risk assessment of an in-use building with scaffolding installed. This is a specialist task and a reference could be made to PAS 9980.
- The HSE's guidance should be revised to properly advise those planning and undertaking work on the holistic risk profile of the building, not just focusing on the risk on the scaffold itself.
- Finally, HSE and fire and rescue authorities should be informed and trained on these risks, to enable them to suitably participate in the safety management system with the potential for enforcement where needed.

C Expert Panel Comments

The panel agrees that this is a concern. There are numerous residential buildings in the country where remedial works are happening, usually due to failures in the external wall construction.

Under the Construction (Design and Management) Regulations 2015, the contractor should carry out a comprehensive risk assessment to ensure that the works they are undertaking do not present an unacceptable risk. If the building is occupied whilst the works are ongoing, then the risk assessment should include the occupants. That risk assessment should include issues such as the introduction of combustible materials during the works (e.g., scaffold boards, scaffold sheeting, or more) and try to ensure that the risk is reduced as much as possible. It should also consider the works methods (e.g., if the works include removal of combustible insulation, where is it stored once removed?) and any other risks (e.g., will the works affect any existing fire precautions, such as smoke vents?). This should be given serious consideration before any works start.

HSE's guidance, **HSG 168>** has recently been updated and does give some guidance on this (paragraph 207, Figure 11, and more).

In addition to the above it is worth remembering that whilst the Contractor has responsibilities, so does the existing Responsible Person (RP), under the Regulatory Reform (Fire Safety) Order 2005 (FSO) in England and Wales (with similar legislation in devolved administrations). The RP must also consider these risks, holistically, and work with the contractor so each of them are aware of the risks and cooperate in minimising the impact (e.g., that the contractor is aware of any smoke control outlets). Given the potentially complex nature of the process, this will, no doubt, require the services of a competent person to assist the RP (and contractor), and also highlights the need for all stakeholders to meet and discuss these issues as early as possible.

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Cladding failure in strong winds

CROSS Safety Report Report ID: 1172

A reporter writes with concerns about a repeat failure of building cladding, in severe but not exceptional winds, that saw panels fall to the public street below.

Key Learning Outcomes

For architects, engineers, and other cladding specifiers:

- Cladding design and installation should be given the same degree of attention as the primary structure to improve safety, reliability, and longevity
- Design responsibilities for the whole cladding system should be clearly defined
- Consider the inspection and test plans required to demonstrate the adequacy of fixed cladding

For civil and structural design engineers:

- Select the correct fixings for the given loads and environment
- Design with robustness in mind
- If possible, attend site to inspect the installation of cladding systems and their fixings

For construction professionals including cladding contractors:

- Adequate quality assurance and competent supervision can help to ensure that cladding systems are installed in accordance with the design

R Full Report

A reporter writes with concerns about a repeated failure of modern cladding in severe but not exceptional winds that caused a hazard to public safety. Large lightweight aluminium panels fell from a building onto the public street below. Fortunately, no one was injured, but the incident could have easily been more serious.

Errors in the design and/or construction of the cladding works were found during investigation survey work says the reporter. The sheeting had been previously repaired but the severity of the inherent weaknesses in the installation apparently not recognised or remedied during the previous repairs.

The section of cladding which failed showed evidence of having been refixed. Some failed fixing points showed signs of multiple drill holes or enlarged drill holes. Loose or incorrectly installed fixings were observed in other parts of the remaining cladding. The reporter believes the absence of a complete continuous cladding support system may have contributed to the failure. Many panel edges and joints were observed as unsupported including near a corner. The reporter recommended a replacement cladding support system as part of the required remedial works.

> **the absence of a complete continuous cladding support system may have contributed to the failure**

The reporter goes on to say that the poor installation of the cladding, its restraints and the fixings, likely resulted from a lack of expertise applied during the construction process. Furthermore, the reporter believes there must have been an absence of suitably experienced supervision during the works for the installation to exist as found.

The reporter also suspects gaps in the design knowledge of the original specifier of the cladding, gaps in the contractor's knowledge, and that conditions of the construction contract could have impacted what was originally built. The reporter concluded that thorough attention should be given to the detailing and supervision of cladding works.

C Expert Panel Comments

This report highlights several concerning issues, including design, specification, procurement, installation, and construction supervision, all of which can cause, or contribute to, failure of cladding systems.

An issue with cladding is that there is often not one person responsible for the overall design of the system. The sheets may be specified by one designer with primary and secondary steelwork designed by another. Supposedly minor elements such as cladding rails, say at corners, edges and openings, may be specified (but perhaps not designed) by the cladding contractor with the responsibility to consider fixings varying across projects. Such fragmentation of responsibilities leads to design interfaces where risk can thrive. Where design is fragmented, the responsibilities of each designer should be clearly defined with one designer taking the lead to ensure all interfaces are considered. Care should be taken to ensure procurement processes do not prejudice coherent design interfaces. It is essential that all elements of the cladding system are adequately detailed on construction issue drawings, and that these drawings, regardless of the different suppliers, provide coherent instructions for site fixing. In the case reported here, it is clear that panel edges and joints were found to be unsupported which should not happen.

> **fragmentation of responsibilities leads to design interfaces where risk can thrive**

The failure reported here occurred under severe but not exceptional wind conditions. There is sometimes not enough understanding of the disproportionately large wind loads that occur at the sharp edges of buildings and roofs, and at the edges of cladding panels, all of which need to be adequately fixed and restrained. Designers should ensure robust designs with key areas of installation highlighted to ensure safe designs. CROSS recommends 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.

Fixings are critical

Clearly, appropriate fixings must be designed and specified. Fasteners must be fixed in accordance with the manufacturer's requirements, including with the correct equipment to ensure that adequate fixings are achieved. Fixings can vibrate loose and it is impossible to predict the air pressure fluctuations that cause this. The correct choice of fixing can ensure that fixings do not loosen through wind or vibration induced effects. There can be numerous problems with self-tapping fixings into cold rolled sections. One issue is that the pull-out value is very sensitive to even very minor changes in rail metal thickness. So much so, that on some designs the cladding rails need to be chosen not for their overall bending capacity but for the metal thickness to assure adequate fixing pull-out. Care is also required where countersunk fixings are proposed as countersinking can significantly reduce the capacity of fixings. In all cases, fixing design should be done by a specialist to ensure sufficient redundancy, longevity and compatibility. CROSS report **Metal cladding panels fail and fall to ground>** published in 2022 concerned the failure and detachment from a building of metal panels. The report considered issues of design, manufacture and fixing of sheeting including the need for vibration resistant fasteners. The **Construction Fixings Association>** provides guidance for the design and execution of fixings. Significant attention to all aspects of fixings is required.

Correct site fixing of sheeting must be assured. Marking out of site fixings must accord with the design to ensure that minimum edge distances and the like are achieved. Quality control procedures should demonstrate that the installation meets the cladding system specification which sets down materials, workmanship and testing requirements. It is essential that there is adequate supervision of subcontractor activities to ensure the satisfactory execution of works. Arrangements for the inspection and acceptance, including inspection and testing plans, of subcontractor packages should be carefully considered and agreed upon. The demonstration of the adequacy of concealed fixings requires particular thought. Consideration should be given to the provision of independent supervision for all aspects of the construction process where safety critical fixings are concerned.

Further reading

References that readers may find helpful include:

- Institution of Structural Engineers publication **Structural aspects of cladding>** which is aimed primarily at engineers to assist in the structural design of many types of cladding systems.
- Ciria publication **Cladding fixings (C524)>** provides good practice guidance on fixings to attach cladding to the structure of a building.
- SCI publication **Best practice for the specification and installation of metal cladding and secondary steelwork (P346)>** presents guidance to designers and contractors on the specification and installation of profiled metal cladding systems and the supporting purlins and side rails.

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Junction of partitioning walls and ceilings

CROSS Safety Report Report ID: 1156

A potential issue has been raised with CROSS, regarding the order of works in partitioning assemblies and how these can affect the performance of compartmentation.

Key Learning Outcomes

Designers, internal partitions contractors, and dry lining operatives:

- Those who are programming the works need to be aware of the importance of fully completing the installation of one component before progressing works of connecting tasks
- Site operatives also need to be aware that they should not progress in connecting ceiling works before all works to the concealed wall element are completed

R Full Report

A potential issue has been raised with CROSS, regarding the order of works in partitioning assemblies and how these can affect the performance of fire compartmentation.

The reporter has come across a number of situations where plasterboard wall partitioning has been installed to the soffit, with a suspended ceiling forming an additional junction below the soffit. They consider this a very common detail which can exist either as a standalone partition wall, or in a lining configuration internal to a concrete wall.

The usual sequence of works is to install the studs and partitioning boards and then tape and joint them to complete the finishing off. Depending on the sub-contracting of the works, it can be possible that the plasterboard wall finishing off (taping and jointing) is carried out by a separate team (a wet trade team) to that which installs the stud and boards (a dry trade team).

It follows that if the same team installs the boards and the ceiling, a situation can commonly occur where the part of the stud wall above the ceiling is not taped and jointed before the ceiling is installed. Once the ceiling is installed, then access for taping and jointing is harder, and the respective follow-up team may not proceed with the works, leaving that section of the partition unfinished. This could lead to a degradation in performance of the partitioning through the existence of gaps in the joints, which in some instances may relate to compartmentation performance and the respective fire resistance requirements of insulation, integrity, or protection to the structure.

> **the division of wet and dry trades on site**

The problem appears to arise from the division of wet and dry trades on site, and the failure to complete wet works to the partition before dry trades complete the ceiling works. This indicates at a lack of appreciation of the importance of the taping and jointing by the contractor programming teams, along with a potential failure of coordination by the teams on site.

To address this issue, the reporter is suggesting that those who are programming the works need to be aware of the importance of fully completing the installation of one component before progressing to connecting works. Similarly, site operatives also need to be aware that they should not progress in connecting ceiling works before all works to the wall element are completed.

C Expert Panel Comments

Hidden areas

The issue in this report is genuine and seems to be that hidden areas (e.g. above suspended ceilings) do not get completed properly. The lack of attention given to hidden areas is a common problem within the industry because any faults there are harder to see and inspect. These failures in the finishing of compartmentation work are quite regularly identified during thorough inspections and there needs to be a process implemented where those responsible for the programming of works are aware of the need to avoid this occurring. This is an awareness, skills, and knowledge issue, recognising the fact that many involved in this process may not have the appropriate understanding of the potential outcome of their actions, or inactions.

robust quality control process needed to ensure that the system is built as designed and tested

It is, of course, just as important to fully complete the parts of the wall construction that are in hidden areas, as it is to complete them in visible areas. Manufacturers' details need to be followed and a robust quality control process needs to be in place to ensure that the system is built as designed and tested, checking that these issues are completed before the areas are covered up. Adequate site supervision, by suitably qualified and experienced persons, is needed to ensure such works are executed and inspected correctly.

Clearly, in the reported cases, the wall design and integrity will be compromised. Partition walls are a system, and they need to be assembled as such. The affected performance depends on the layers of boarding, the staggering of joints, and evaluating the additional benefit of taping and jointing in each case, in order to try to understand the consequences of omitting this process.

Tangentially, but of equal importance, is that penetrations through the walls in hidden areas are often not fire stopped correctly. The panel has come across plenty of examples of poor fire stopping of post-fixed services in hidden voids and, for example of unsealed gaps through walls, or the complete lack of compartmentation walls above suspended ceilings.

CROSS has published similar issues on compartmentation in reports **706 on fire safety failings in residential blocks>**, **1039 on fire compartmentation detailing>**, and **1115 on ineffective fire socks>**.

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Masonry panels rock in wind due to missing wall ties

CROSS Safety Report Report ID: 931

Wall ties designed to connect masonry partitions to adjacent steelwork framing were not installed leaving the masonry walls unrestrained. Walls were seen to be rocking in high winds.

Key Learning Outcomes

For clients:

- Consider the significant benefits derived from independent inspection of works in progress

For builders and client's site representatives:

- Quality assurance processes and competent supervision can help to ensure that the structure is built adequately
- Consider introducing a quality assurance procedure for the inspection of safety critical elements such as wall ties and masonry restraints

For architects, engineers, and other building designers:

- Ensure correct wall tie densities, embedment lengths and all fixing details are shown on construction drawings
- Be aware that 'buildability' can significantly impact what is built
- During site visits check that the correct wall ties are being installed adequately
- Be aware that incorrectly installed wall ties can lead to wall failures

R Full Report

A reporter saw that partition walls in an industrial unit under construction were rocking in high winds. The 215mm thick masonry walls were being built between 6m high steel columns which were acting as windposts.

An investigation found that wall ties specified to fix the masonry to the windposts had not been installed leaving the walls unrestrained above floor level. It transpired that the main contractor's representative had witnessed some wall ties being fixed to the steel posts but had not witnessed all areas of the masonry erection. At the time of building the walls, the mason had apparently protested that it was difficult to install the wall ties. The reporter, therefore, thought it likely that the mason simply did not install ties when not being observed. Other walls of various heights within the building were found to be similarly unrestrained.

C Expert Panel Comments

A lack of appropriate ties or appropriately fixed ties has been the cause of many wall failures. The lack of embedment of ties between leaves of cavity walls contributed to a collapse at a school in Edinburgh and major remedial work to many others. The Standing Committee on Structural Safety (SCOSS) Alert **Inquiry into the construction of Edinburgh Schools>** published in 2017 provided an overview of the failings investigated and a number of the recommendations that followed.

The absence of wall ties is a critical failing that should never happen. As in this reported example, the ties connect the masonry to the structure and without these ties, the masonry may be inadequate and unstable. Windposts in walls, externally or internally, provide support to the masonry dividing the walls into panels which are then adequate to resist wind and lateral loads. Without the windposts (and adequate ties between the masonry and the windposts) the masonry may collapse. Internal masonry, such as the partition walls reported, will still likely be exposed to significant lateral loadings during its life. The walls will be subjected to wind loads during construction when the external shell is incomplete, as appears to have been the case here. The walls will also be subjected to wind loadings in the finished building (especially if there are dominant openings) or indeed, be subjected to lateral loadings arising out of the use of the building. The installation of wall ties as intended under the design is therefore a critical activity.

> **the installation of wall ties as intended under the design is a critical activity**

The designer's intent must be clearly communicated to the persons building the walls. The masons on-site must have clear and understandable information showing all the details of what they are to build. Details of all masonry units, mortars, ties, masonry reinforcement, windposts, flashings and DPCs must be provided in a suitable format.

In the case reported here, the mason had apparently protested that it was difficult to install the wall ties. Whilst difficulty of installation was absolutely no excuse not to install the ties, designers should note that 'buildability' is a key part of design, and that more buildable designs will be less difficult to construct as the designer intends.

> **designers should note that 'buildability' is a key part of design, and that more buildable designs will be less difficult to construct as the designer intends**

Contractors should be encouraged to engage competent masons. Supervision of all works by the contractor must be adequate and appropriate to the works in hand. Where works are hidden from view on completion (such as wall ties built into masonry) then the supervision arrangements must be sufficient to establish adequacy as works proceed, or compliance testing undertaken.

Clients should consider inspection arrangements

Independent inspection of work, through a clerk of works, resident engineer, or other site inspectors, can lead to the early identification of inadequate work but can also change the mindset and approach of those working on-site. This change in mindset and approach can improve both the quality and effectiveness of completed work. Designers visiting sites can help ensure that their design intent is understood and implemented. For all projects, regardless of scale, clients should consider what inspection arrangements are required taking into account safety criticality, complexity and many other aspects of the work, including the impact of poor quality work and subsequent failings on their organisation's standing and reputation.

All clients, designers, contractors and operatives, particularly masons, should be very aware that poorly built walls can collapse. In the event of a failure of the wall causing death, there would likely be investigations for gross negligence manslaughter for an act by an individual and for corporate manslaughter against any organisations involved.

> **In the event of a failure of the wall causing death, there would likely be investigations for gross negligence manslaughter**

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