

# CROSS

Confidential Reporting on Structural Safety

## Newsletter 54 | April 2019

### Editorial

Systemic failures occurred in global banking in 2008 causing huge losses and a lack of confidence in financial institutions. Root and branch changes followed to strengthen the sector and improve stability. The offshore energy industry was appalled by the 1988 Piper Alpha disaster when an explosion and fire destroyed a rig in the North Sea and 167 died. A fundamental review followed of the processes used; new standards were introduced, new regulations framed, and the culture changed. That is until the 2010 Deepwater Horizon event when a blow-out destroyed the rig creating the world's biggest oil spill. In 2011, a White House commission concluded that the spill resulted from "systemic" root causes. The lesson is that change needs constant updating.

Systemic problems have been identified in recent failures, some resulting in multiple deaths. The two crashes of Boeing 737 Max aircraft killing 346 have been linked to software and the aeroplanes are grounded until a solution is found. The disastrous collapse of a tailings dam at a mine in Brazil in January 2019 led to at least 170 deaths. There have been numerous such dam failures and subsequent calls for much stronger regulation internationally. In March 2019, a cruise ship lost power to all four engines in rough seas off a dangerous coast, and had the anchor not held, there could have been a disaster. No doubt manufacturers, operators, and regulators will be examining the cause. Each case has involved engineering systems and the difference between a near-miss and a catastrophe can be marginal.

The Independent Review of Building Regulations and Fire Safety by Dame Judith Hackitt found systemic issues



**DIRECTOR:**  
**Alastair Soane**

within parts of the construction and regulatory processes in the UK and calls for wholesale changes in our approach. Similar findings have been made in Australia in the past year. Indeed, are all these cases indicative of weak Regulations and their enforcement? There are tensions in many countries between the those who want less regulation and those who do not.

Many of the issues have been identified in CROSS reports over the years and by constantly bringing these to the attention of industry as examples of precursors, more serious, and perhaps catastrophic, events may be prevented. Achieving cultural change is hard.

Leadership is key and in construction this means that safety considerations must be the focus of attention in all organisations; be they asset owners, designers, contractors, suppliers, regulators, building managers or government departments.

*Alastair Soane*

### CROSS

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### CONTENTS

- 705** Use of untreated billet connections in precast concrete structures > **2**
- 764** Hidden defects in railway masonry arch viaducts > **3**
- 786** Incorrect load testing of steel lifting frames > **4**
- 788** Concrete grade confusion in software > **5**
- 789** Temporary stability of steel frame building > **6**
- 790** Inadequate product testing for shear studs > **7**
- 803** High winds cause parapet failure > **7**
- 804** Inadequate structural design on some industrial steel structures > **8**
- 624** Wind loads acting on timber frame walls for designs to BS 5268-6 > **9**

### HOW TO REPORT

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



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

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

### KEY

- (R)** CROSS Report
- (C)** CROSS Panel Comments
- (N)** News
- (I)** Information
- >** Denotes a hyperlink

## 705: Use of untreated billet connections in precast concrete structures

### REPORT

Whilst completing a third-party (CAT3) appraisal of a large external precast concrete structure subject to dynamic and fatigue loads, it was identified that the beam to column connections were formed using solid steel billet pieces which were inserted into sleeves and pockets cast into the side of the columns. The billets were fabricated from untreated steel plate, which was then protected using grout poured into the beam/column interface pockets at completion of the works.

The billets were intended to form the primary shear transfer mechanism between the beams and columns. However, further analysis indicated they were insufficient for this purpose and additional support columns were introduced which rendered the billet connection as a temporary support only.

The concern is that in structures subject to dynamic or fatigue forces, the poured grout will be susceptible to cracking and over time will lead to water ingress and corrosion of the billet. This raises associated long-term concerns of corrosion, spalling and in the extreme potential failure of the connected parts. Guidance from the precast concrete designer suggested this detail was commonplace in precast structures, hence there is a risk that this in-built corrosion trap will exist in other exposed precast structures.

### COMMENTS

Off-site manufacture, including the use of structural precast concrete elements, places considerable reliance on connections. For major bridge works, a design life of 120 years is not uncommon so all elements must be capable of operating satisfactorily for that time span. Because of the embedded positions of billets, repair or replacement would be extremely difficult. As noted by the reporter, fatigue and corrosion resistance need to be considered at the design stage for all elements including billets and their immediate surroundings.

### "Off-site manufacture, including the use of structural precast concrete elements, places considerable reliance on connections"

For some building structures, such as car parks, billets have been used for years in connections between precast joints. Whilst subject to cyclical thermal loading and vibration, joints in car parks are however usually given a reasonable amount of weather protection by virtue of location and waterproofing surfacing on roofs. References to such connections can be found in various texts; for example The Concrete Centre publication [Design of Hybrid Concrete Buildings](#) and the Temporary Works Forum publication [Precast concrete - good practice and common issues in temporary works](#).

Any evidence of corrosion or other problems arising from the use of billets would be welcomed by CROSS.



[SUBMIT REPORT >](#)

[SUBMIT FEEDBACK >](#)

### INFORMATION

#### What should be reported to CROSS?

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

Near misses, or observations relating to failures or collapses (which have not been uncovered through formal investigation) are also welcomed.

Reports do not have to be about current activities so long as they are relevant.

Small scale events are important - they can be the precursors to more major failures.

No concern is too small to be reported and conversely nothing is too large.

Your report might relate to a specific experience or it could be based on a series of experiences indicating a trend which may require industry or regulatory action.

#### Benefits of CROSS

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

#### Supporters of CROSS

- Association for Consultancy and Engineering
- Bridge Owners Forum
- British Parking Association
- Chartered Association of Building Engineers
- Construction Industry Council
- Department of the Environment
- DRD Roads Services in Northern Ireland
- Get It Right Initiative
- Health and Safety Executive
- Highways England
- Institution of Civil Engineers
- Institution of Structural Engineers
- Local Authority Building Control
- Ministry of Housing, Communities and Local Government
- Network Rail
- Scottish Building Standards Agency
- Temporary Works Forum
- UK Bridges Board

## 764: Hidden defects in railway masonry arch viaducts

### **R** REPORT

A reporter is concerned about the sell-off of spaces under railway arches. This was brought to their attention by an [article in Issue 852 of the Rail Magazine](#)>. In the event that space under railway arches is sold off then it becomes almost impossible for inspection and maintenance to be carried out. The article says *"the risks of something really disastrous resulting from this sale cannot be discounted"*.

Selling off the leasehold for 125 years is likely to lead to some major difficulties in a few years, according to the reporter, since there may be defects already hidden behind linings. The reporter is aware that many inner-city arch viaducts, where the space below the arch is used for small businesses, have not been inspected for years and of those few that have been inspected, defects have been found that have required immediate remedial action, although in some cases that has not always been successful.

The freight loading on some of these structures is such that the joints between the bricks open and close repeatedly as the train passes over. Small amounts of mortar are lost occasionally, leading to greater movement over time.

The reporter believes that this problem needs to be addressed if a potential collapse is to be averted and thinks that the process could best be started by raising this issue with CROSS.

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**"The freight loading on some of these structures is such that the joints between the bricks open and close repeatedly as the train passes over. Small amounts of mortar are lost occasionally, leading to greater movement over time."**

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### **C** COMMENTS

Railway engineers have a long tradition of monitoring, maintaining and keeping safe old masonry bridges. There is also a long tradition of business premises being located underneath bridge arches and rail authorities have powers to access these as they require. There are occasions when defects are discovered during inspections so the ability to gain access for visual sightings to look for problems and precursors of failure is important.

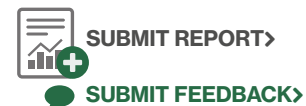
The reporter is right to raise a concern and the matter has been considered by the railway authorities. An [article in Railway Technology from September 2018](#)> states *"Network Rail has sold the sites on a leasehold basis with plans to retain access rights for using the property for railway operations in future"*. It is understood that the railway arch sell-off is supported by robust measures to ensure that the asset management inspection and assessment requirements for the loadbearing railway arch structures can be met. The new regime will of course need to demonstrate this will remain the case.

A more recent approach is to install long-term monitoring systems in old bridges to evaluate the deterioration of the structure and to determine the effectiveness of previous maintenance measures. This may include sensors to measure distributed deformation, acoustic emission sensors at specific damaged locations, and high sensitivity accelerometers to measure the dynamic response of the structure due to vibration caused by trains passing over. The sensing data is then interpreted remotely. However, concerns have been expressed to CROSS about the ability of even the most advanced accelerometers to measure critical movements for masonry bridges. In long viaducts, where there can be many tenanted arches, an additional challenge is to decide which arches to monitor.

As part of Network Rail's research and development (R&D) programme, they publish [challenge statements](#)> to raise industry awareness of their priority challenges and to promote research and development into new ideas and technologies to solve them. They have published a [challenge statement on Tenanted Arches](#)> and are inviting the supply chain to help with R&D

activity for remote condition monitoring, hidden inspection techniques and improved detection of defects by way of example.

The views of readers on this subject would be welcome.



### **N** NEWS

#### **CIRIA general and safety-critical fixings guides**

CIRIA published two new guides on fixings in January 2019.

#### **General fixings - guidance on selection and while-life management (C777)**>

#### **Management of safety-critical fixings - guidance for the management and design of safety-critical fixings (C778)**>

Both guides contain references to CROSS reports and SCOSS publications.

CIRIA have also published three videos to accompany the guides.

#### **Fixings into Concrete**>

#### **Lightly Loaded Fixings**>

#### **Forever Fixings**>

## 786: Incorrect load testing of steel lifting frames

### REPORT

On two occasions a reporter has been responsible for the design of steel lifting frames used to assist in the handling and transport of piping equipment in the weight range of 5-10tonnes. The normal design and fabrication process for these items is for the engineering contractor to provide a design drawing to a steelwork fabricator indicating: the geometry, detailing and load test requirements for the steelwork frame; the required capacities and sizes for associated rigging items; as well as carrying out design calculations to ensure the lifting frame is suitable for the applied loads during use/ testing.

The lifting frame is fabricated by a subcontracted steelwork fabricator and then passed to a specialised lifting/testing subcontractor (engaged by the steelwork fabricator) for load testing. Load testing is usually specified in the range of 1.5 to 2.0 times the safe working load of the frame and includes testing of the associated rigging items. Certification is then provided by the lifting/testing subcontractor to allow use of the lifting frame. A witness from the engineering contractor is usually (although not always) present during the load test.

On the first occasion, says the reporter, the rigging had not been installed in accordance with the design drawing, and none of the testing subcontractors' employees even had a copy of the design drawing with them at the site. It was evident that actual in-service loads would have exceeded those applied during the load test, potentially uncovering a manufacturing defect during use that had not been found during testing. The lifting frame would have been used in close proximity to personnel and sensitive equipment, and given the weights involved, any defect or failure could easily have caused a fatality or significant damage.

**"It was evident that actual in-service loads would have exceeded those applied during the load test, potentially uncovering a manufacturing defect during use that had not been found during testing"**

On the second occasion, continues the reporter, the frame was again incorrectly rigged, tested, certified and shipped for use. Back calculations showed that the load test using the incorrect rigging had not applied loads which exceeded the actual in-service loads. The frame certification was voided and a second load test, using the correct rigging, was arranged. Again, the under-application of loads had the potential to mask a failure which could have resulted in a fatality or damage.

The reporter is concerned about an apparent lack of understanding regarding the criticality of lifting operations and a poor attitude evident at the lifting and testing subcontractors' premises. It is especially concerning considering that the lifting and testing subcontractor should be 'the expert' in such matters but seems to be unaware of the importance of the work they are undertaking or the impact of deviating from engineering documents. The reporter is concerned about how many other load tests may have been carried out incorrectly without being noticed, and whether this is happening regularly elsewhere in the industry.

### COMMENTS

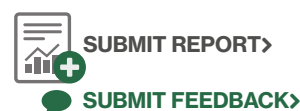
The **Machinery Directive (2006/42/EC)** and the enacting legislation in the UK (**The Supply of Machinery (Safety) Regulations 2008**) provide the requirements for load testing of lifting machinery and lifting accessories. The legislation states that "when lifting machinery or lifting accessories are placed on the market or are first put into service, the manufacturer or his authorised representative must ensure, by taking appropriate measures or having them taken, that the machinery or the lifting accessories which are ready for use - whether manually or power-operated - can fulfil their specified functions safely". Static and dynamic tests must be performed on all lifting machinery ready to be put into service. The lifting frame discussed in this report is likely to be classified as a lifting accessory and **BS EN 13155 Cranes - Safety - Non-fixed load lifting attachments** is one of the relevant standards. **The Lifting Equipment Engineers Association (LEEAA)** provide clear guidance on both how to comply with the legislation and how to transfer key information between the designer, manufacturer and user.

**The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)** place duties on people and companies who own, operate or have control over lifting equipment. This includes all businesses and organisations whose employees use lifting

equipment, whether owned by them or not. In most cases, lifting equipment is also work equipment, so the **Provision and Use of Work Equipment Regulations (PUWER)** will also apply. Both LOLER and PUWER include requirements for examination, inspection and maintenance.

All lifting operations involving lifting equipment must be properly planned by a competent person, appropriately supervised and carried out in a safe manner. HSE, LEEA and many private organisations publish guidance on the regulations, standards and good practice, so it is surprising, and of concern, that in the cases reported above, there seemed to be no knowledge of the law in this regard. There may be a need for better understanding of the regulations and standards in the industry.

The key message from this report is that what is designed must be built, within acceptable tolerances. This raises the question of whether the appropriate level of expertise in the field is always able to recognise change in order to trigger either correction of the working method or re-design. For the cases discussed in this report, perhaps there should be a requirement in the contract with the lifting and testing contractor for photographs of the test so that the designer can undertake a visual check to compare as-designed with as-built rigging/test procedure.



### NEWS

#### All-Party Parliamentary Group (APPG) on Working at Height

Structural-Safety provided evidence to the APPG on Working at Height, for which the final report was published in February 2019.

#### Staying Alive report >

Recommendation 2 in the report is:

*"The appointment of an independent body that allows confidential, enhanced and digital reporting of all near misses and accidents that do not qualify for RIDDOR reporting. The data collected by this independent body will be shared with government and industry to inform health and safety policy."*

## 788: Concrete grade confusion in software

### REPORT

A reporter reviewed a third-party design of a composite floor deck and noticed that the design calculation report had been generated by a proprietary software package which called for "concrete characteristic strength = 45N/mm<sup>2</sup>". There is no information in the calculation confirming whether this refers to the cylinder or cube strength.

The drawings correctly called up that C45/55 concrete was required, however, unfortunately grade C35/45 was poured on site. This appears to have been caused because whoever ordered the concrete was more familiar with the calculation report than with the drawings. Upon seeing "concrete characteristic strength = 45N/mm<sup>2</sup>", they thought that this meant C35/45.

Fortunately, cube test results taken when the floors were poured showed that the concrete mix eventually achieved the 45N/mm<sup>2</sup> needed. However, there is a lesson to always be clear as to what concrete grade is being specified, and to make sure the drawings take precedence over the calculations to show what is to be built.

The reporter has contacted the software developer to suggest they amend their software.

**"There is a lesson to always be clear as to what concrete grade is being specified"**

### COMMENTS

For designed concrete, the 'concrete characteristic strength' is the lower number and is meant to be a true representation of the strength as opposed to the 'characteristic cube strength', which is a measure of the strength expected from control cubes. The double designation was meant to improve understanding, however, it does rely on a level of competency from designers and contractors.

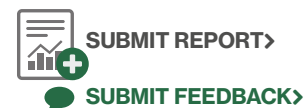
The Concrete Centre publication [How to specify concrete for civil engineering structures using BS 8500](#) and the [National Structural Concrete Specification \(NSCS\)](#) provide further information on specifying concrete, including inspection and testing requirements.

In 2014, the BBC published an article [Great miscalculations: The French railway error and 10 others](#) about failures due to mismatches in units. One example was the 1999 \$125m Mars Orbiter, designed as the first interplanetary weather satellite, that was lost because the NASA team used metric units while a contractor used imperial. An investigation said the "root cause" of the loss was the "failed translation of English units into metric units" in some software. A far cry perhaps from mixing up C35/45 and C45/55 concrete, but in the history of engineering failures there have been catastrophic examples consequent on mis-interpreting units.

**"For designed concrete, the 'concrete characteristic strength' is the lower number and is meant to be a true representation of the strength"**

A fundamental aim of any structural design is clarity of intent and clarity on the specifics of any product or material used. [A recent CROSS report on steelwork](#) pointed out that it was impossible to differentiate between grades simply by appearance and the same goes for most concrete. That said, a contractor should seek clarification from the designer in case of doubt about differences between calculations and drawings. Normally the drawing would be assumed to be correct.

A typical Swiss cheese model for avoiding failure provides a series of checks and one of these should be to make sure that designs and drawings are compatible.



### NEWS

#### Temporary Works Forum (TWf) precast concrete guide

The TWf published a precast concrete guide in February 2019.

#### Precast concrete: Good practice and common issues in temporary works

Structural-Safety are noted as a corresponding member of the Working Group for developing the guide.

The guide includes references to CROSS reports related to precast concrete.

C	40/50	
'C' for normal weight concrete <sup>a</sup>	Cylinder strength <sup>b</sup>	Cube strength <sup>c</sup>
'LC' for lightweight concrete		

a Includes heavyweight concrete  
 b Minimum characteristic cylinder (150 mm diameter by 300 mm) strength, N/mm<sup>2</sup>  
 c Minimum characteristic cube (150 mm by 150 mm) strength, N/mm<sup>2</sup>

● **Figure 1**  
Explanation of the compressive strength class notation (The Concrete Centre, How to specify concrete for civil engineering structures using BS 8500, 2007)

## 789: Temporary stability of steel frame building

### REPORT

This event concerns the temporary stability of a 4-storey steel frame structure with precast concrete planks and a structural topping. A reporter says that during the erection of the structure, the contractor had provided temporary steel bracing to a number of the bays to stabilise the structure and prevent it from swaying. The bracing was in the form of flat steel plates arranged diagonally.

Whilst attending site, the visiting structural engineer found one of the bracing members unbolted at the base of a column. The column where the bracing should have been fixed to was located at the perimeter of the building where the outside ground level was lower than the internal slab level. To protect operatives from falls, edge protection had been provided. But when installing the edge protection, the bracing had been unbolted.

The situation was plainly unsafe and indicated both a disregard for safety by the operative who unbolted the bracing and a lack of control, supervision and oversight from the main contractor.

For the same project, several concerns were found about the temporary works design for the temporary stability of the frame:

1. During the project, the engineer had communicated that until the concrete planks were grouted together, the diaphragm for distributing the lateral loads should be assumed to be incomplete. The implication of this was that the stability of the structure was the responsibility of the contractor until the diaphragm was complete.

The steel frame subcontractor was responsible for both the erection of the steel frame and the landing of the precast concrete planks. Whilst they were willing to take on design responsibility for the temporary stability of the steel frame without planks, they passed on design responsibility for the steel frame when the precast planks had been landed to the main contractor.

This division of responsibility was unexpected and led to confusion between the two temporary works designers, with the steel frame subcontractor using moment fixity from the beam end-plate connections and the main contractor

assuming perfectly pinned beam-column connections that required cross-bracing. The latter approach eventually proved to be very conservative and had to be revised to be cost effective.

2. When the main contractor began the temporary stability design for the steel frame with concrete planks, they requested to see the calculations that had been completed by the steel frame subcontractor for the frame without planks. Stability was justified based on the moment capacity of the end-plate connections and whilst this principle was sensible, there were no accompanying calculations. The structural engineer deemed this was insufficient to demonstrate that the frame would be stable during construction.

There are, says the reporter, two lessons learned from the above experiences. The first is that temporary works designers for main contractors may not have adequate experience to undertake the temporary works design for the stability of a steel frame. Given the size of the structure, the lack of calculation initially provided by the steel subcontractor was also of concern and may be indicative of a more widespread problem within the industry.

The second lesson is that splitting design responsibility for temporary works inevitability provides opportunity for confusion, but thankfully did not endanger safety in this case.

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**"This division of responsibility was unexpected and led to confusion between the two temporary works designers, with the steel frame subcontractor using moment fixity from the beam end-plate connections and the main contractor assuming perfectly pinned beam-column connections that required cross-bracing"**

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### COMMENTS

Structural-Safety has always advocated that there should always be one designer with overall responsibility for stability. Whilst this normally applies to preserving stability of the finished structure, the principle ought equally to apply during construction when arguably the risk of an instability failure is highest.

Regulation 13 of CDM 2015 ultimately places the duty on the Principal Contractor to plan, manage and monitor the construction phase and coordinate matters relating to health and safety during the construction phase to ensure that, so far as is reasonably practicable, construction work is carried out without risks to health or safety. In all situations, the Principal Contractor's Temporary Works Coordinator (TWC) (or Contractor's if a small job) should have oversight of maintaining stability. However, the designer should be involved in a collaborative manner to ensure stability at all times.

This report also highlights the potential value of visits by the design team who may (as on this occasion) identify a problem. A current trend to minimise site attendance by the design team is most undesirable; a matter that was brought up in the [Edinburgh Schools Inquiry](#) > and the [Independent Review of Building Regulations and Fire Safety: final report](#) >.

Reference should also be made to [BS 5975, Code of practice for temporary works procedures and the permissible stress design of falsework](#) > and [PAS 8811, Temporary works - Major infrastructure client procedures - Code of practice](#) > as well as the [Temporary Works Forum website](#) > for guidance on the management of structures in temporary conditions. Specific to steel framed building, the [BCSA Guide to the Erection of Multi-Storey Buildings](#) > provides advice on maintaining stability during construction.



SUBMIT REPORT >



SUBMIT FEEDBACK >

## 790: Inadequate product testing for shear studs

### REPORT

Proposed structural strengthening for a project involved welding shear studs to existing steelwork to form a composite connection to new concrete. To avoid welding, an alternative bolted shear stud was investigated. A manufacturer of a commonly used product had a variant product which had been used elsewhere on similar structures.

The variant is not covered by a Euronorm, European Technical Approval Guidelines (ETAGs) or similar. The manufacturer provided information for their principal product and additional testing information for the variant product. On investigation, the testing information was found to be based on a university student Master's dissertation.

Whilst the reporter's organisation did not review the dissertation in detail, it was felt that reliance on such a source would not be equivalent to the general quality assurance principles of Euronorms or similar. Even as a source of technical information, the reporter

would suggest that a dissertation is of interest only. In the absence of peer review and opportunity for comment, or repetition as with a published technical paper, it may not demonstrably be a reliable source of information.

### COMMENTS

In very many cases, designers place absolute reliance on the origin of design information from suppliers. It is expected that such information has come from a reliable source and been rigorously checked in accordance with proper standards to justify industrial application. A Master's dissertation however is prepared with the purpose of the student's learning. The two are not at all the same and, as a default, cannot be used for the same purpose.

If relying on a Master's dissertation as verification testing, the person doing so has the duty to check that the student's work in all ways meets the requirements for verification. Quite apart from the diligence of

the student and the scope of tests, matters such as the Quality Regime (e.g. to UKAS for the purpose intended) and PI insurance are also important.

Care must also be taken in relying upon documentation and SCOSS has warned of this before. In the **SCOSS Alert Anomalous documentation for proprietary products - February 2013**, SCOSS said that they had become aware of a number of instances where certification accompanying proprietary products has stated compliance with standards or specified requirements, but the products have been found not to be in accordance with the specification. On several occasions, this has led to premature structural failure of the component at loads well below the intended design capacity.



[SUBMIT REPORT >](#)



[SUBMIT FEEDBACK >](#)

## 803: High winds cause parapet failure

### REPORT

A building has a roof top plant area above the fourth-floor level. The area is screened by timber fencing of approximately 1.7m above the top of the masonry parapet wall, which is in turn fixed to vertical posts that are secured to the wall. There was no evidence of raking bracing to the screen or support posts. The parapet is approximately 0.9m high (excluding copings) and overlooks a 3-storey light-well that is situated within the confines of the building and is South Easterly facing. The parapet is approximately 225mm thick masonry in English bond. It is possibly lime mortar bedded and topped with rolled-top, terracotta, saddle copings.

In 2018, there were exceptionally strong South-Easterly winds with gusts of approximately 50+mph (80 km/hr). Under these conditions the wall collapsed, and inspection revealed that the parapet and affixed screening had been pushed over. The masonry had failed on the bed joint across almost the whole of its length. The left side of the parapet was a free edge with the right side bonded to a chimney. It is assumed that the action of the strong winds on the screening allowed sufficient pressure



● **Figure 2**  
Failure of masonry wall with fencing above

to cause the screen and fence to be overloaded and, as the wall has little tensile strength, the failure resulted along the bed joint closest to the roof level. At the base of the lightwell was a rooflight into an occupied space. Had the parapet slipped and fallen into the lightwell there could have been substantial damage and possibly fatalities.

### COMMENTS

There is a similarity here to the **collapse of a wall in Melbourne Australia in 2013**. A 3.2m-high advertising hoarding was up to 70cm taller than the ground level free-standing brick wall to which it was added. The wall blew down and three people were killed. There have been other cases where attaching hoardings have increased the

windage on walls, which are vulnerable anyway, and have precipitated collapse. Although this report is about a wind loading failure, it has parallels with an **earlier CROSS report on balconies**, where the reporter was concerned that the balcony designer had anchored their cantilever to some inner structure without verifying that it was adequate for the task. Every structure must be looked at as whole. Danger lurks at interfaces between units or at interfaces between divided responsibilities as in report 789 in this Newsletter.

Adding to the height of cantilever walls must always be taken seriously as, if the load is a UDL (like wind), the bending moment at the base is proportional to the square of the height. It is not known if there was a designer in this instance but there should have been and had there been casualties or fatalities, the responsibility would have come back to the owner of the premises.



[SUBMIT REPORT >](#)



[SUBMIT FEEDBACK >](#)

## 804: Inadequate structural design on some industrial steel structures

### **R** REPORT

On some industrial projects associated with plant, a reporter's firm believes that steel structures are being erected without a design being carried out by a competent structural engineer and are therefore potentially dangerous.

This may be because some suppliers are CE marking structures to the Machinery Directive rather than the Construction Products Directive. The latter is the more appropriate for steel structures, and products should be certified to both Directives in cases of overlap.

The firm also consider that the CDM Regulations are being widely disregarded resulting in avoidable hazards during construction, operation, maintenance and demolition. Since the plant structures are usually unoccupied, Building Control approval is not required and there is therefore no external oversight.

Furthermore, the plants are often described as mobile even though they are usually fixed in position for many years and this may provide further loopholes in regulation.

### **C** COMMENTS

The Machinery Directive, Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006, is a European Union directive aimed at the free market circulation of machinery and at the protection of workers and consumers using such machinery. Its main intent is to ensure a common safety level in machinery placed on the market or put in service in all member states. There is, it would seem, no requirement for such machinery to come within the scope of the Building Regulations.

Regulation 9 of the Building Regulations, Exempt buildings and work, states that the regulations do not apply to the erection of any building or extension of a kind described in Schedule 2. Schedule 2 lists different classes of exempt buildings and work, of which Class 2 is buildings not frequented by people and includes "a detached building into which people go only intermittently and then only for the purpose of inspecting or maintaining fixed plant or machinery". There are further requirements for Class 2

buildings, depending on how close they are to other buildings and the site boundary.

This unfortunate anomaly in UK legislation means that there are types of structure which are exempt from Building Control. These might be frames supporting plant which might thereby have to support both heavy loading and vibratory loads which are especially hazardous and require especially skilled design e.g. against fatigue and vibration.

On the basis that the reporter describes the arrangement as a 'structure' and refers to a structural engineer, then it's probable the design and construction phase of the 'structure' will fall in scope of CDM. Even if it were argued that CDM doesn't apply, on the basis that there is an undertaking (a commercial project) and workers and/or public may be exposed to risk, then the general duties of the Health and Safety at Work etc Act 1974 may apply to all CDM dutyholders.

Once constructed, then generally Building Control can deal with all structures (not just buildings) when they become dangerous. However, depending upon the circumstances, the HSE may be the most appropriate enforcing authority. It is not unusual for the HSE and Building Control to work in partnership.

**"Even if it were argued that CDM doesn't apply, on the basis that there is an undertaking (a commercial project) and workers and/or public may be exposed to risk, then the general duties of the Health and Safety at Work etc Act 1974 may apply to all CDM dutyholders"**



**SUBMIT REPORT >**

**SUBMIT FEEDBACK >**

### **N** NEWS

#### **CROSS United States (CROSS-US)**

In association with Structural-Safety, Glenn Bell, Senior Principal of Simpson Gumpertz & Heger, President-elect of SEI (Structural Engineering Institute; part of ASCE), and an IStructE Board member, has laid down the framework for CROSS-US with SEI as the principal sponsor.

Also involved is NIST (National Institute of Standards and Technology) with the prospect of other Federal Agencies to follow. CROSS-US will be launched shortly and can be accessed through [www.structural-safety.org](http://www.structural-safety.org)

### **N** NEWS

#### **CROSS Germany (CROSS-DE)**

Structural-Safety are working with the **Association of Design Review Engineers >** in Germany to set-up CROSS-DE.

As part of this partnership, two CROSS-DE reports discussing CE-marking of products have been published on the Structural-Safety website.

**DE-01 Incorrect CE-marking of products >**

**DE-02 Products installed without CE-marking due to lower cost >**

### **N** NEWS

#### **The Warren Centre**

**CROSS-AUS >** and Structural-Safety are liaising with **The Warren Centre >** in Australia on topics of common interest to work on together.

The recent publications from The Warren Centre below may be of interest to CROSS Newsletter readers.

**Fire Safety Engineering >**

**Five Recent Structural Disasters and What We Can Learn From Them >**



## 624: Wind loads acting on timber frame walls for designs to BS 5268-6

### REPORT

A reporter says that the masonry shielding factors in BS 5268-6 (K100 and K200) [Ref. 1] allow substantial reductions to be taken on the wind loads acting on timber frame walls. When PD 6693-1 [Ref. 2] for designs to EC5 was produced, the masonry shielding effect was substantially reduced apparently because the original BS method was not adequately vetted. Although BS 5268-6 was withdrawn in 2010 without the K100 and K200 factors being amended, the standard continues to be used in the UK. There are two points the reporter makes about this:

1. Where BS 5268-6 is used in new designs, the masonry shielding factors could result in a design that has a safety factor much lower than the designer actually thinks it is. Few engineers would be aware of the question mark over the validity of the K100 and K200 factors.
2. When specifying remedial work; inadequate remedial work may be specified if the original K100 or K200 factors were taken into account again.

BS 5268-6.2 was first published in 2001 while the more widely used BS 5268-6.1 was published first in 1988 and a revision was published in 1996 with an amendment on 2007 making the standard over 10 years old. The use of withdrawn standards is never a good idea as they are not maintained and updated to correct mistakes and to take advantage of new knowledge and practices.

Ref. 1 BS 5268-6.1:1996 Structural use of timber - Part 6: Code of practice for timber frame walls - Section 6.1 Dwellings not exceeding seven stories

BS 5268-6.2:1996 Structural use of timber - Part 6: Code of practice for timber frame walls - Section 6.2 Buildings other than dwellings not exceeding four storeys

Ref. 2 PD 6693-1:2012 Recommendations for the design of timber structures to Eurocode 5: Design of timber structures Part 1: General - Common rules and rules for buildings

### COMMENTS

This report is a good example of the potential risks involved with designing to withdrawn codes. The interaction under wind load between the inner timber frame leaf and outer masonry leaf in timber frame walls is complex and may not be fully understood. Both BS5268-6 and PD6693-1 provide simplified procedures which attempt to quantify masonry shielding in a rational and safe manner, though the reporter is correct when stating that a lesser proportion of wind load is resisted by the masonry in the PD6693-1 procedure.

The background to the more recent PD6693-1 procedure is documented in BSI papers. To the best of the knowledge of CROSS, no

derivation for the older BS6268-6 procedure, which has been applied for over 20 years, has been found. It would appear that masonry shielding calculations would be better done to the current procedure in PD6693-1 (EC5 support document) than to the procedure in the withdrawn BS 5268-6 standard.

In general, it is not good practice to use withdrawn standards and their application may prove difficult to justify to a client or court in the event of a problem arising.



[SUBMIT REPORT >](#)



[SUBMIT FEEDBACK >](#)

### NEWS

#### Free-standing masonry walls

**A six-year-old girl was seriously injured** when a brick boundary wall in Basildon collapsed onto her.

Basildon Borough Council pleaded guilty to breaching Section 3(1) of the **Health and Safety at Work Act 1974** and has been fined of £133,333 and ordered to pay costs of £21,419.55.

In 2014, SCOSS published an Alert on free-standing masonry walls.

**SCOSS Alert: Preventing the collapse of free-standing masonry walls >**

### PARTICIPATION

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

### FEEDBACK

If you have any comments or questions regarding this CROSS Newsletter, please [Submit Feedback >](#).

### CPD PRESENTATIONS

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

For more information contact [events@structural-safety.org](mailto:events@structural-safety.org).

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