

CROSS

Confidential Reporting on Structural Safety

Newsletter No.52 | October 2018

Editorial

Safety in buildings and infrastructure assets is in the headlines both within the industry and in the wider press.

The harrowing nature of the Grenfell Tower fire continues to be revealed as firefighters and responders give their evidence to the Public Inquiry. The catastrophic collapse of the viaduct in Genoa has now focused attention on ageing infrastructures everywhere. Extreme weather events have caused great loss of life and enormous material damage in the US and the Far East due to high winds and floods. There have been devastating fires in some parts of the world.

Those in the front lines of defence against extreme events, natural or man-made, include structural and civil engineers in their jobs as designers, constructors, inspectors, or maintainers. By rigorous attention to safety and robustness in those sectors for which they are responsible, they can, and do, make a positive difference in protecting the public.

CROSS is expanding internationally and after several years of effort CROSS-AUS for Australasia was launched in Adelaide at ASEC (Australasian Structural Engineering Conference) in September by Faith Wainwright, President of The Institution of Structural Engineers. There is a segment of the CROSS website devoted to this and the call is out for reports from the region.

Congratulations to our colleagues in Australia for getting this initiative under way. CROSS-AUS reports will be on the same database as CROSS UK reports so information on problems, and solutions, can be shared by all who look at the website. Plans for schemes in



DIRECTOR:
Alastair Soane

other countries to join the network are under way.

In this Newsletter are reports demonstrating deficiencies and near-misses on projects large and small. The bearings on a major new bridge have caused concern. A support post for a street sign fractured, sadly causing a fatality.

There have been several reported collapses, and a grey area has been identified whereby walls were removed in a multi-storey building without permission having been obtained. As a variation on our usual theme, a success story demonstrating good engineering practice is also included.

After 51 Newsletters in the original format, the time has come for a new style and, thanks to Paul Mc Nulty our Senior Engineer, this is the result. Paul has also been promoting a scheme for posting CROSS reports on social media which is proving very successful and generating plenty of interest and discussion.

Alastair Soane


CROSS

VISIT: www.structural-safety.org > EMAIL: newsletters@structural-safety.org >

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HOW TO REPORT

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

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

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

KEY

-  CROSS Report
-  CROSS Panel Comments
-  News
-  Information

781: Quality of design and construction of a major bridge structure

REPORT

This report concerns the design and installation of the bridge bearing zones on a new precast prestressed reinforced concrete viaduct. The reporter had concerns about the design and installation of bridge bearings and the main precast prestressed concrete beams.

Design problems:

1. Anchorage of bottom tensile reinforcement was insufficient which may compromise shear capacity at the bearing location. A bearing schedule issued before construction showed ultimate vertical load on the bearing of around 3,000kN. The schedule issued after the bridge was constructed, and design had been challenged, showed this vertical load to have been reduced to around 2,000kN. This was explained by more refined computer modelling.
2. There was insufficient edge distance at the back of the elastomeric bearing. The code calls for minimum of 45mm not including any construction tolerances. Zero tolerance was provided because the bearing size increased once detail design by a specialist supplier was finalised.
3. Insufficient edge distance between bearing and front face of a supporting pier. Similar issue to point 2 above. Concerns over effective load transfer in this area.
4. The designer did not consider bridge gradient. All bearings were designed to sit level on a pier bearing shelf and to be in place before the main girder installation. However, the main precast concrete girders were installed on a small gradient. This resulted in a smaller contact area and possibly localised overstressing of bearings.
5. Incorrect construction sequence was provided in the design documentation. The construction sequence called for the bridge beams to be positioned directly on top of elastomeric bearings with a thin layer of epoxy grout. However, as the bridge beam was installed on a small gradient, full contact surface between bridge bearing and precast concrete girder could not be achieved. This resulted in localised bearing overstressing and damage.

Construction problems:

1. The contractor followed an incorrect construction sequence without question.
2. The specialist bearing supplier was not engaged to provide installation advice.
3. Full contact surface between bearing and bridge superstructure was not achieved. This resulted in localised bearing damage.

In conclusion, the reporter questions the competency of those involved including the designer, the detailer of the beams, the category 3 checking engineer, and indeed the client for signing off the detailed design. Many of the personnel, he says, were not trained or experienced in bridge construction.

The bridge entered service following a period of intensive design checking and remedial works on site. The design life of bearings and their failure mode in the future is however, according to the reporter, uncertain.

COMMENTS

It is worrying that we should come across such a large and complex structure being, apparently, so poorly designed and executed. Especially so at a time when we are all so focused on quality of design and construction and after there have been recent major bridge failures.

Key factors in avoiding such issues are to use experienced Chartered Engineers for both design and construction, and to have regular and effective communication between all parties.

Importantly, is this an unusual case? New bridges in the UK are designed and built in accordance with robust procedures; lessons having been learned from past failures.

"Key factors in avoiding such issues are to use experienced Chartered Engineers for both design and construction, and to have regular and effective communication between all parties"

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

Competency of all concerned is a critical component of such processes and the Hackitt Report **Independent Review of Building Regulations and Fire Safety** > stressed the importance of this having found competency to be 'patchy' in the building industry.

There are currently several groups led by CIC (Construction Industry Council) looking into how competency is defined, measured, achieved, and maintained. Competent personnel at several levels with the organisations who created this bridge should have detected the potential problems and acted before the components came together on site.

Experienced designers know that attention to detail is vital if satisfactory and safe designs are to be realised. Hence skilled design (i.e. not just analysis) requires the ability to think ahead within the iterative design process and 'claim enough space'

at the outset for the final design to be achieved.

The correct selection of bearings and the transfer of designs into detailed drawings are critical and should highlight issues such as bearing tolerances. The reporter says that the issues here were generally resolved but they should not have arisen in the first place.



SUBMIT REPORT >

SUBMIT FEEDBACK >

N NEWS

CROSS-AUS launch

Faith Wainwright, 2018 President of The Institution of Structural Engineers, launched CROSS-Australasia in Adelaide on 26 September and called for professionals to submit CROSS reports:

"As professional engineers we have a profound duty to ensure the safety of all those who use the structures we design and build.

Sharing feedback on near misses or concerns is not always easy and CROSS is a successful community platform to allow professionals to do this simply, without attributing blame."

Visit CROSS-AUS website >

793: Street sign collapse causes fatality

R REPORT

This report highlights the potential dangers of street signs on fixed vertical supports subject to wind loading and draws attention to a possible failure mechanism in welded section support posts with defective joints.

The findings arise out of an investigation following the death of a pedestrian who was walking past a sign that failed during high winds in 2015.

The sign was located adjacent to a public footpath and highway. The support was a single steel hollow square section post measuring 130mm by 130mm at the base, tapering to 62mm by 62mm at the top. The post was 4,460mm in height and a steel rectangular plate had been welded in place on top. A plastic box section sign measuring 1,200mm wide by 1,800mm high was attached to another steel plate, which was then bolted to the rectangular support plate.

The support post had been formed with sections of steel U-channel which had been butt welded end to end to create the full length of the post. The square section was formed with longitudinal welds between the

two full length channels. The transverse butt welds to each U-channel were offset so that no full cross section transverse weld occurred in the post.

The post had been embedded approximately 600mm into the ground and into a concrete foundation. The 1,200mm by 1,800mm box sign had been in place for two months, replacing a sign that had measured 1,009mm wide by 725mm high. The age of the post is not known.

The incident occurred during a named storm force event. During the event, a gust wind speed was measured at 68mph some 17miles away from the sign. The exact speed at the sign location is not known. On the morning of the incident, a pedestrian was walking past the sign when the support post broke apart, striking and fatally injuring passer-by.

A metallurgical examination was carried out on the support post which had fractured approximately 2,600mm above ground level at one of the transverse weld sections. The transverse butt weld at the fracture location exhibited regions of incomplete



Figure 1
Failed support post

weld penetration through the post wall and internal corrosion.

A fatigue crack was present in the full-length U-channel adjacent to the butt weld and had initiated at the unfused edge of the transversely welded channel. The unfused areas would have raised the local stresses in the post, reducing resistance to fatigue crack initiation, propagation and an increased susceptibility to failure.

Whilst the larger sign would have increased the forces acting upon the post and were a contributory factor in the post failure, calculations indicate that the support post would not have structurally failed had it been free from defects.

Whilst it is acknowledged that the incomplete weld and internal corrosion may not have been obvious as part of a routine

"calculations indicate that the support post would not have structurally failed had it been free from defects"

inspection, this shouldn't detract from the importance placed on the inspection and maintenance of all assets, including those that are ubiquitous and seemingly low risk. This tragic event also highlights the need to properly assess the condition and suitability of elements that may be affected when alterations are made.

COMMENTS



A fatality that occurred because of faults in a mundane piece of street furniture and should not have happened.

In the same category are garden walls that fall on children and signs above shops that fall on pedestrians. These are not the result of deliberate acts but of the importance of structural matters not being understood.

Those responsible for the procurement of signs, posts, advertisement hoardings, lamp posts and other ancillaries to our streets must be aware that they are dealing with

potentially life-threatening issues and act accordingly.

Specifications must be of a high enough standard to give confidence that the components in question will give long, reliable, and safe service. The same standards must be followed through for construction, inspection, and maintenance.

 [SUBMIT REPORT >](#)
 [SUBMIT FEEDBACK >](#)

778: Casting, transporting and installing precast concrete kerbs

REPORT

The construction consisted of precast concrete robust kerbs to contain the permanent way for railway lines. The project was designed pre-construction and the kerbs were designed as single entities running separately up along each side of the ramp.

The primary challenge, according to the reporter, was the limited level of access via track possession for craneage to lift and install each individual kerb (of which there was up to 100 in total). The program required track possession for each kerb installation which was not feasible or acceptable.

The solution, as shown in the photograph, was to design and cast a 'U-kerb' using a section of the in-situ cross ramp stitch as part of the precast connecting the original single standalone kerbs. The permanent works designers were responsible for re-designing the U-kerbs, however it was the Principal Contractor and the Temporary Works Coordinator (TWC) who were tasked with designing the lifting points.

As the fabrication process was carried out outside of the country of installation, an external consultant was contracted to carry out an inspection regime for each pour, which also extended to all lift anchors.





● **Figure 2**
U-shaped precast kerbs

Initially, it was envisaged that a 20T pick-and-carry crane would be utilised to carry these kerbs up along the ramp to their final locations, however, with the emergence of a new item of specialised plant called the 'monster crane', it was deemed a much more controlled and safer option to install a set of rails up along the ramp and have this Road Rail Vehicle (RRV) deliver the U-kerbs via the rail tracks.

The reporter says that the combined engineering thinking featuring the principal contractor's engineering team, the permanent works designer, the client and the precast supplier enabled a solution to be found that could be constructed safely. The entire process from re-design to installation was co-ordinated by the TWC for the project, which ensured a smooth transition from design through to the final product was achieved.

COMMENTS

CROSS generally reports on failures, but reports are also welcome which highlight how positive designs can be implemented to achieve overall safety.

 [SUBMIT REPORT >](#)
 [SUBMIT FEEDBACK >](#)

INFORMATION

Why is CROSS confidential?

CROSS confidential reporting techniques were developed by NASA for the aviation industry in the USA.

A confidential system allows safety issues to be reported without creating concerns in areas like co-worker relations, client loyalty, or insurance.

Any identifiable details, such as a project, product, individual or organisation, are completely confidential to CROSS.

Reporters' personal information is collected to verify the contents of the report, and to communicate with the reporter, but this also remains confidential.

692: Collapse of lifting tackle connected by threaded bar

REPORT

No one was struck or injured when a set of 3T chain blocks and a 1m length of 20mm diameter threaded bar fell from a height of 5m, according to a reporter. The lifting tackle (chain blocks) was suspended from a hook attached to a lifting anchor. This consisted of a threaded bar system that joined 2 bars together using a proprietary coupler in accordance with an approved design.

The top of the threaded bar was cast into a concrete slab above an arch. The bottom length of the threaded bar had become unscrewed from the top length causing the bottom bar and attached lifting tackle to fall. The blocks were not being used to lift at the time.

The reporter identifies several causes for the incident, including that the anchor was not installed in accordance with the design, and the supervisor made a decision, which was not checked or condoned by the engineer, to install the arrangement.

The reporter lists several key messages learned from the event:

- Teams should make sure that details of engineering designs are understood and implemented in accordance with the designs.
- Teams should make sure that they have assurance arrangements in place to check compliance with installations of design.
- Teams should engage with the workforce to check whether there are 'local' arrangements in place to manage issues that they observe whilst undertaking works.

COMMENTS

This is a tension system and any tension system has to be looked at very carefully indeed. Over the years we have had several tension system failures (from numerous causes) but one characteristic is that the system can lack ductility which can lead to failure. The lack of ductility in this case was that the thread was not fully engaged.

Secondly, the consequences of any tension system failure are gross (fall distance will most likely be considerable) whereas this is much less likely in a comparable compression system. Lock nuts, locking screws, or other secondary means of achieving security should always be considered in tension systems.

Temporary works situations are as important as permanent works in such circumstances. Poor communication must be avoided and competent personnel utilised who understand and implement what is required.



[SUBMIT REPORT >](#)

[SUBMIT FEEDBACK >](#)

782: Collapse of glass balustrade from feature staircase in public building

REPORT

Further to report [734 Glass smoke screens and structural safety >](#), published in Newsletter No. 51, a reporter was reminded of the time when they investigated an incident where a glass balustrade panel fell vertically from a 'feature' staircase in a public building. Fortunately, there were no injuries.

The installers had used a proprietary stainless steel and rubber bracket to connect the four corners of the glazed panel to the steel frame but must have omitted the locking pins which pass through the panel and instead were relying on clamping friction. The panel fell at night, presumably due to lower temperatures marginally reducing the volume of the rubber gasket.

The pin was not visible due to the construction of the bracket. Confusingly, similar looking brackets exist with a higher

clamping force and no locking pin. Very much a secondary element which was on nobody's check or inspection list.

COMMENTS

This is an interesting report. On many other occasions CROSS has emphasised the general safety demand of periodic inspection adding that critical components ought to be 'inspectable'. Structural failure has occurred where access was simply impossible (say to detect corrosion).

This report is an example illustrating what can happen when there is no QA/QC on installation and where in service (or post-installation) inspection is more or less impossible.

Cases where there have been failings of glass panels can be found by entering "glass" in the Quick Search box on the Structural-Safety website. For example:

[182 Glass panel fixings failure >](#)

[336 Modifications to balustrades in a shopping centre >](#)

[340 Nuts falling from tension glazing system >](#)

[734 Glass smoke screens and structural safety >](#)

[756 Collapse of domestic glass balustrade due to inadequate fixings >](#)



[SUBMIT REPORT >](#)

[SUBMIT FEEDBACK >](#)

714: Unsafe removal of some internal walls

R REPORT

A reporter, who is a structural engineer, was requested to advise, in an informal manner, on the removal of some internal walls in a decades' old multi storey block of council flats constructed from mostly in-situ concrete and brick/block.

A construction professional purchased one of the lower level apartments from the council and proceeded to remove some internal walls. They did this without adequate investigation or obtaining professional advice from a structural engineer, and without consent from the council landlord of the surrounding residences.

Subsequently, on learning of the wall removals, the council requested a report from a structural engineer on the implications. The reporter provided a vague, carefully worded opinion qualified by multiple caveats.

However, the salient point is that removal of structure, which may have been loadbearing, was able to be done with the full knowledge and under the instruction of a construction professional without due care and attention and which might have resulted in disaster for the residents above.

The reporter feels that this illustrates the massive void in public protection that we, as an industry, allow to exist without campaigning for legal protection before an event. This requires, according to the reporter, a sea change in the initiation, planning, execution and supervision of all construction activities. It is of little benefit to society to take legal action after a collapse has occurred.

C COMMENTS

Changes to a structure at any stage of its life must be treated seriously. All too often alterations are made to structural elements by those who do not know whether they are load-bearing or not. Obviously, there should have been investigations and consultations at an early stage and certainly before anything was demolished.

The issue is, as the reporter says, that there is no mechanism for catching those who ignore proper procedures. There may be uncertainties in understanding vis-à-vis the difference between freehold and leasehold rights with the erroneous assumption that if you own the freehold you can do what you want.

Another common misconception is that if a wall is not 'structural' then there is no need to engage with Building Control. This is not true, and in any case, the determination of whether a wall is structural or not, is often based upon tapping it with knuckles to see if it sounds solid or not.

Although the reporter does not say whether Building Control were involved or not, we should all see the benefit in the second check provided by Building Control.

However, with a modern building, detecting the difference between a load-bearing wall and a partition may not be obvious. For example, in timber buildings or those with lightweight frames and this is a strong argument for creating and keeping digital records that stay with a property throughout its life and are updated when there are changes.

"The issue is, as the reporter says, that there is no mechanism for catching those who ignore proper procedures"

Presumably there was a builder involved in which case they should have asked, or known, whether there were structural implications. Then, because the client was a construction professional, there are further questions of competency and ethics to be addressed. The cultural change needed to prevent such events might include much higher penalties for non-compliance with regulations.



SUBMIT REPORT >



SUBMIT FEEDBACK >

742: Add-on roof truss failure

REPORT

Visiting a property for an unrelated matter, a reporter spotted something odd about the roof; the gable had bulged one end and movement had clearly occurred.

The building was a flat roof modular system and the Operations and Maintenance (O&M) manual explained that the modules arrived with a waterproof roof, and that trusses were added above.

There was no access, so a hole was made for inspection. Inside the reporter found the bracing to the trusses fixed with a single nail and there was discontinuity in the bracing. The main issue however was that as the truss didn't support the ceiling (as the module came with a roof), there was no diaphragm under the trusses and all the force in the bracing went to the gable end through the final brace.

The photo shows there is a nail pull out failure on the penultimate truss and it appears the brace wasn't even connected to the wall/sole plate. Following the inspection, bracing was added along with noggins at the areas of highest deformation and additional fixings were made. The reporter says that designers need to be careful putting trusses over an existing flat roof.



● **Figure 3**
Bracing deficiencies in the timber roof

COMMENTS

This appears to be a case where no one was in charge of the overall stability system or had any clear vision of what the load paths were intended to be. Having this vision, and assuring it is realised in practice, is always vital but is acutely so when there is more than one party involved in the supply chain or the provision of stability, as appears to be the case here.

The reporter makes a very good point and one to be aware of when using trussed rafters with no diaphragm arrangement to the bottom chord. How many engineers would have considered this aspect during design?



[SUBMIT REPORT >](#)

[SUBMIT FEEDBACK >](#)

NEWS

Forensic Engineering: learning from failures course

On 16 October, the free Massive Open Online Course (MOOC) "Forensic Engineering: learning from failures" launches on edx.org.

This MOOC explains the Delft Method for Forensic Investigations, pays attention to the Life Cycle of a structure, steps of an investigation and provides aids to generate possible causes and tips on how to come to trustworthy outcomes.

The course consists of 6 modules, which can be finalised within 6 months.

[Find out more >](#)

PARTICIPATION

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

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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